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Ms. Laura Tesch
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Subject: Comments on EPA's May 2013 Bristol Bay Assessment

Ms. Tesch,

Per your request, ERM has reviewed selected aspects of the United States Environmental Protection Agency's (EPA's) *Assessment of Potential Mining Impacts on Salmon Ecosystems of Bristol Bay, Alaska, Second External Review Draft EPA 910-R-12-004b*, April 2013 (hereafter "the Assessment"). Presented herein are ERM's comments on the Assessment. The ERM subject-matter experts (SMEs) contributing to the review are listed below, together with the specific subject areas on which they focused:

- David Blaha – Lead Technical Reviewer focusing on overall aspects of the Assessment;
- Bruce Marsh – Technical Reviewer focusing on overall aspects of the Assessment;
- Peter Southern – Technical Reviewer focusing on overall aspects of the Assessment, in particular related to standard mining practices;
- Daniel Yamashiro – SME focusing on pipeline release scenario and associated fate and transport analysis;
- Ross Mitchell – SME focusing on Subsistence Use and Socio-economics;
- John Gangemi and Paul Krause – SMEs focusing on Fish and Fish Habitat;
- Sinang Lee and Tania Barron – SMEs focusing on Community Health & Safety.

ERM's comments are organized by topic area.

GENERAL COMMENTS

Nature and Implications of the Assessment

The Assessment is the second draft of a report initially released in May 2012. A change registry indicating where revisions have been made and/ or how EPA has responded to public comments has not been identified to date, and would be appropriate given the context of this document.

The Executive Summary of the Assessment states that it, "...evaluates the potential impacts of large-scale mining development on salmon and other fish populations, wildlife, and Alaska native cultures..." and that it was, "...conducted as an ecological risk assessment...". An Ecological Risk Assessment (ERA), by its very nature, is a scientific analysis of ecological resources, and its scope (by design) excludes many considerations related to the effects of development of mineral resources in Alaska. To this point, the scope of the Assessment, as defined by EPA, excludes many stakeholders from a robust public participation process.

The EPA's claim that the Assessment is an ERA notwithstanding, the Assessment includes elements of both an ERA and an Environmental Impact Assessment (EIA), but the Assessment is not a comprehensive example of either.

- The Assessment claims to be an ERA (p. 2-1), but that is not reflected in its title and Abstract, which in fact implies that it is an EIA. It does not establish any clear goals or objectives. EPA guidance (Application of Watershed Ecological Risk Assessment Methods to Watershed Management, EPA/ 600/ R-06/ 037F, March 2008) states that:

  > Clear management goals must be set before the assessment team jumps into analysis. It is quite common that assessments often hastily include a few obvious goals and then devote most of the effort to data gathering and analysis (Reckhow, 1994). Valuable data may be collected, but if the goals are poorly defined, the data may not be useful in management decisions (Ward, 1996, p. 14).

- The Assessment states that it has three endpoints (p. 5-1):

  > We consider three endpoints in this assessment: (1) the abundance, productivity, or diversity of the region's Pacific salmon and other fish populations; (2) the abundance, productivity, or diversity of the region's wildlife populations; and (3) the viability of Alaska Native cultures. Each of these endpoints meets the criteria of ecological relevance, management relevance, and potential susceptibility to stressors associated with large-scale mining.

In fact, the Assessment does not quantify impacts or risks to any of these endpoints. The Assessment does not discuss mining effects on the abundance, productivity, or diversity of the region's salmon or other fish populations, but rather simply reports on the estimated impacts to stream channels and wetlands. It then states that risks to the region's wildlife and Alaska Native cultures is related to impacts to salmon, but it never quantifies the impacts to salmon, and therefore it cannot reach any meaningful conclusions regarding the potential risks to wildlife or Alaska Native cultures.

- Consistent with EPA ERA guidance, the Assessment presents a conceptual model, which serves as a basis for analyzing and characterizing risks (Box 2-1, p. 2-2). The conceptual model clearly includes consideration of "modifying factors," which "influence the delivery, expression, or effects of stressors." However, the term "modifying factors" is never used again in the Assessment. This highlights one of the primary flaws of the report – the nearly total lack of consideration of any mitigation or management measures that may avoid, minimize, or mitigate the impacts of mining in the Bristol Bay watershed.
- Although EPA states that this assessment is "not an environmental impact assessment" (p. 1-2), there are many aspects of the Assessment that suggest it is intended to be an impact assessment (e.g., the focus is almost exclusively on a single source – the Pebble Project). In any case, it is not a complete impact assessment, as it is working from hypothetical mine plans, only considers adverse effects (ignoring the benefits of mining, which would be a required component of a NEPA document), and disregards the use of mitigation to reduce impacts.

Addressing Uncertainty

A key element to an ERA is to transparently present the known uncertainty. Perhaps the greatest uncertainty for the Assessment relates to the mine scenarios on which EPA bases its evaluation. Every finding and conclusion in the Assessment is based on a hypothetical (Pebble) mine design. However, the Assessment summarily dismisses this issue by stating that the lack of an actual mine design is "not a source of uncertainty, but an inherent aspect of a predictive assessment" (p. ES-27). While it is certainly possible to conduct an impact assessment on a hypothetical scenario, EPA's Assessment dismisses all of the unknowns (including important mitigation measures that a standard mine would implement) associated with the mine design and operations plan as having any potential effect on its findings.

This is particularly troublesome since, despite not having any specific information on the mine design or proposed mine operations; EPA characterizes the impacts presented in Chapter 7 of the Assessment (Mine Footprint) as inevitable (p. 7-1).

Scale, Context, and the Relative Amount of Potentially Affected Resources

The Assessment blurs and distorts the scale of the hypothetical mine scenarios, and the associated hypothetical impacts, which results in a lack of critical context for its quantitative conclusions, and misleads the reader regarding the significance of its findings.

The report claims to consider five spatial scales (p. 2-7):

- Bristol Bay watershed – 115,500 km^2;
- Nushagak and Kvichak River watersheds – 59,890 km^2;
- Mine Scenario watersheds - 925 km^2;
- Mine Scenario footprint (max Pebble 6.5 scenario) – 75 km^2; and
- Transportation Corridor – 113 km.

The Assessment is entitled *An Assessment of Potential Mining Impacts on Salmon Ecosystems of Bristol Bay, Alaska*, but in fact, the Assessment does not attempt to assess impacts to salmon at the Bristol Bay watershed scale. The Bristol Bay watershed is referenced in characteri zing the importance of the fishery and other resources of the watershed, but no impacts are discussed at this scale. In fact, although the five spatial scales are described in the Executive Summary and repeated in the Introduction, the fish resources analysis fails to perform legitimate analysis, if any, at the intermediate scales.

The Assessment states that it focuses on the Nushagak and Kvichak River watersheds, but in fact it does not. No impacts to the Nushagak or Kvichak Rivers are identified related to normal mine operations. In fact, the only potential impact to these rivers identified in the report relates to a tailings dam failure.

The Assessment is really an assessment of potential mining impacts at the Mine Scenario Watershed and Mine Scenario footprint scales, focusing largely on worst case scenarios. All impacts occur at this scale, which represent 0.8% (Mine watershed) and 0.06% (Mine Max Scenario Footprint) of the Bristol Bay watershed (Table 2-1, p. 2-8). This sense of the relative scale of the hypothetical mine scenario is not discussed in the Assessment, which is

unfortunate, because it would give the readers a true sense of the scale of the potential impacts related to the hypothetical scenarios.

In addition to failing to provide context for the stated impacts, the Assessment also fails to discuss the relative amount of the various ecological resources that it states will be affected by the hypothetical mine scenarios. Specifically, the Assessment describes impacts in terms of loss of stream channel length and wetlands areas, altered stream flows, and indirect impacts to streams and wetlands for various hypothetical mine scenarios; however, the Assessment does not put these losses into any kind of perspective or characterize these habitats in terms of the proportion of the total resource base that they represent at any of the five spatial scales previously identified. It is further noted that stream length alone is not a sufficient indicator of habitat productivity. EPA's assumption that all stream reaches have equally productive habitat is not valid.

For example, the Assessment predicts the loss of 145 km of streams (under the Pebble 6.5 Scenario). The Assessment fails to reference that this represents only 0.27% of the 53,000 km of stream channel in the Nushagak and Kvichak watersheds, and even less in the entire Bristol Bay watershed. A similar calculation could be made in terms of the relative impacts to wetlands.

Perhaps more significantly, the Assessment fails to place the mine-related impacts to anadromous fish habitat in perspective. The Assessment indicates that 35 km of the 145 km of streams predicted to be lost under Pebble Scenario 6.5 are anadromous fish habitat (p. 7-22), but does not present these data in context of the respective spatial scales. Approximately 14% of the streams in the Nushagak and Kvichak watersheds are considered anadromous fish habitat (p. 3-18), so the 35 km of predicted anadromous fish stream impacts represents less than 0.5% of the anadromous fish habitat in these two watersheds, and a substantially lower percentage in the entire Bristol Bay watershed.

The Assessment also fails to discuss the relative amount of the stream channel habitat preferred by anadromous fish that potentially would be impacted, but this value can be characterized by using some of the data presented in the document. For example, the Assessment states that the streams that provide the best habitat for salmon are medium sized streams (0.15 to 2.8 m^3/ sec) with less than a 3% gradient (p. 3-21). The Assessment reports that the percentage of streams meeting these criteria in the Nushagak and Kvichak watersheds is 27% (Table 3-3, p. 3-31), while about 23% of the streams in the Mine Scenario Watershed meet these criteria (Table 7-4, p. 7-16), and only 19% of the streams that are predicted to be directly impacted under the Pebble 6.5 Scenario meet

these criteria (Table 7-6, p. 7-25). This suggests that, on average, the streams that are predicted to be impacted by the mine scenario are likely to be proportionally less valuable than streams elsewhere in the Nushagak and Kvichak watersheds. This kind of analysis is needed in the Assessment to help readers better understand the context and relative value of the habitats predicted to be impacted. Additional data regarding the quality of habitat in the subject area can be found in the Environmental Baseline Document (EBD; PLP 2012).

Furthermore, for a true objective analysis of direct impacts to anadromous fish habitat, the EPA should provide a comparative analysis at each of the five spatial scales, comparing the quantity and relative value of anadromous fish habitat impacted with the total anadromous habitat available at each respective scale. This comparative analysis would demonstrate that the direct habitat loss is less than 1% of total habitat available at the Nushagak / Kvichak scale, and far less at the Bristol Bay scale.

A similar analysis should also be done with fish counts. Using the same data contained in the Assessment, Tables 1 and 2 illustrate proportionally, from a stock perspective, the contribution of sockeye and chinook from the three watersheds in the proposed mine footprint relative to the overall populations in the larger river systems. The stocks spawning in the three tributaries are proportionally small relative to the overall salmon populations in Bristol Bay.

As shown in Table 1, the percentages of the Kvichak watershed annual return of sockeye salmon and commercial catch of sockeye salmon attributed to the Upper Talarik Creek are 0.8% and 1.6%, respectively. Table 2 illustrates similar data for the Nushagak watershed percentages (1.5% and 0.1%, respectively, for the North Fork Koktuli; 4.5% and 0.2%, respectively, for the South Fork Koktuli). These kinds of comparative analysis would be useful to include in the Assessment to help readers better understand the spatial context and relative value of the habitats predicted to be impacted.

Table 1: Sockeye and Chinook Metric Comparisons across Spatial Scales for the Naknek-Kvichak River System

Naknek-Kvichak River System Catch and Count Category	Sockeye	Chinook
Kvichak Annual Return 54 yr avg (1956-2010) (BBA Table 5, Appdx A) [1]	10,407,190	--
Mean Naknek-Kvichak Commercial Catch (BBA Table 1, Appdx A)	8,238,895	2,816
Estimate of Naknek-Kvichak Catch Attributed to Kvichak (62%)[2]	5,108,115	--
Upper Talarik Creek Highest Index Count (Assessment Table 7.1)	82,000	275
% of Kvichak Annual Return Attributed to Upper Talarik Creek	0.8%	--
% of Kvichak Commercial Catch Represented by Highest Upper Talarik Creek Fish Count	1.6%	9.8%

[1] Chinook return data not available in Assessment

[2] Best Available Estimate

Table 2: Sockeye and Chinook Metric Comparisons across Spatial Scales for the Nushagak-Mulchatna River System

Nushagak Mulchatna River System Catch and Count Category	Sockeye	Chinook
Nushagak Annual Return [1] (BBA Tables 5 & 6, Appdx A)	134,272	151,348
Mean Nushagak-Mulchatna Commercial Catch (BBA Table 1, Appdx A)	5,478,820	52,624
Estimate of Nushagak-Mulchatna Catch Attributed to Nushagak (66%)	3,616,021	--
North Fork Koktuli Highest Index Count (BBA Table 7.1)	2,000	2,900
% of Nushagak Annual Return Attributed to North Fork Koktuli River	1.5%	1.9%
% of Nushagak Commercial Catch Represented by North Fork Koktuli River Highest Fish Count	0.1%	5.5%
South Fork Koktuli Highest Index Count (BBA Table 7.1)	6,000	2,750
% of Nushagak Annual Return Attributed to South Fork Koktuli River	4.5%	1.8%
% of Nushagak Commercial Catch Represented by Highest South Fork Koktuli Fish Count	0.2%	5.2%

[1] Table 5 reports 54 year avg. for sockeye from 1956-2012; Table 6 reports 10 year avg for chinook 2000-2009.

Consideration of Mitigation Measures

The Assessment does not take into full consideration measures to avoid or minimize the impacts predicted in the Assessment. EPA does state that it considers good mine practice, but then clearly ignores measures that are routinely used (and often required under permit conditions) to avoid or minimize impacts (e.g., see discussion below regarding discharge of untreated wastewater in the event of a wastewater treatment plant [WWTP] failure). Ignoring these mine management measures results in overstating the impacts from mining activities.

Further, the Assessment admits that it does not take into consideration compensatory mitigation measures (p. 6-4), which the EPA acknowledges

"could offset some of the stream and wetland losses" (p. 7-32). This fundamentally results in an overstatement of the significance of the findings.

To comprise an objective analysis of the potential impacts of a modern-day mining project, any assessment of impacts related to the hypothetical mine scenarios should reasonably consider state of the art mitigation measures that would likely be required to permit one of the hypothetical mine scenarios. EPA's Assessment fails to do this.

The Assessment states that it takes into consideration "modern conventional mitigation practices as reflected in published Pebble materials and as suggested in mining literature and consultations with experts" (p. ES-26), but in fact it does not. For example, the Assessment assumes that in the event of a WWTP failure that water would be released directly to streams. This does not reflect international best practice, which would instead route wastewater in the event of a WWTP failure to either the Tailings Storage Facility (TSF) or the Mine Pit. If this best practice measure was incorporated, none of the impacts referenced in Chapter 8 of the Assessment would occur.

Another example relates to stream flow modification. The Assessment notes, but the Executive Summary does not, that the extent of stream flow modification is very sensitive to the location of the WWTP (p. 7-59). The Assessment also assumes no WWTP discharge to Upper Talarik Creek (p. 7-46). Thus, the Assessment fails to recognize an obvious mitigation measure that would be implemented (and likely required by permit) for the hypothetical project. This is an example of the Assessment's failure to consider measures to optimize water management in ways that could reduce impacts related to stream flow modification.

In terms of wetlands, the Assessment predicts direct wetland impacts and references indirect wetland impacts, but again does not take into consideration potential optimization of water management or reference that mitigation would be required to permit a project similar to the scenario on which the Assessment is based.

Unplanned/Accidental/Failure Scenario Effects

Chapters 8–11 of the Assessment focus on unplanned/ accidental/ failure scenarios. The Assessment's treatment of unplanned events and failure scenarios is flawed, and these events would be highly unlikely to occur if basic best practices were put into effect. The following are several examples:

- The Assessment makes some strong statements that appear to characterize mining in the worst light. For example, the Assessment states:

  > If the mine operator abandons the site, the State of Alaska should assume operation of the treatment system; if both the mine operator and the State of Alaska abandon the site, untreated leachate would flow to streams draining the site (p. 8-2).

  This outcome is highly unlikely, as a necessary condition of permitting such a project today would include financial assurance (bonds) to provide for long term management of liabilities associated with early closure (abandonment of the mine).

- The Assessment, especially the Executive Summary, emphasizes the potential impacts associated with a Tailings Dam Failure, and includes a discussion of the probability of a Tailings Dam Failure. The Assessment concludes that the risk of dam failure associated with a Category II facility is approximately 1 in 2,500 and that the risk of dam failure associated with a Category I facility is 1 in 250,000 (p. 9-10 and 9-11). The Assessment does not justify why it includes both the risks associated with Category I and Category II facilities. Presenting the probabilities of both Category I and Category II facilities is misleading because the tailings dam associated with the mine scenario described in the Assessment would definitely be a Category I facility (with the appropriately more robust design requirements). Thus, the discussion of the Category II facility confuses the reader, and overstates this risk (i.e., risk of failure could be 1 in 2,500 rather than 1 in 250,000), leading the reader to the conclusion that a failure is almost inevitable. This analysis also ignores other important factors such as whether the dams in the data set were constructed using upstream or downstream methods, which EPA indicates is an important consideration (p. 4-16). In summary, EPA's presentation implies an unrepresentatively high probability of occurrence for the dam failure scenario, which is important because (as discussed below) the only impacts that the Assessment indicates would extend beyond the Mine Scenario Watersheds are those resulting from a tailings dam failure.

- Of the specific impacts discussed in the Assessment, the only one that the Assessment indicates would extend beyond the Mine Scenario Watersheds is the Tailings Dam failure, which the Assessment estimates has a 1 in 250,000 chance of occurring per year. Despite acknowledging in the Abstract (p. i) that the failure of a tailings dam has a very low probability of occurring, EPA still finds it necessary to state that a tailings dam failure "would be expected to have "... severe direct and indirect effects on aquatic resources, particularly salmonids" (p. ES-22). In fact, most of the

predicted adverse effects related to mi ning reported in this Bristol Bay Assessment are directly the result of this "low probability" event, although the Assessment does not make it clear which impacts are associated with routine operations as opposed to catastrophic failures.

Accuracy and Precision

The Assessment continues to mislead the reader and misrepresent its findings by incorrectly representing precision and accuracy. The Assessment implies precision by providing results to se veral significant digits (i.e., 0.28 km^2 of wetland impacts in the mine pit, Table 7-7 on p. 7-25). For an ecological risk assessment of a 115,500 km^2 watershed, presenting predicted impacts to this level of precision (i.e., plus or minus a half a hundredth of a square kilometer) suggests to the reader a higher level of precision than actually exists.

The Assessment also suggests these predictions are accurate; while they may support a degree of accuracy for a specific hypothetical mine plan, the Assessment's approach tends to mislead the reader into thinking that the predictions are an accurate representation of impacts from a mine that would actually be constructed in the area. To avoid this, providing results in terms of ranges rather than a single number would better represent the true accuracy of the findings.

Summary of Public Comments

On page 1-6 of the Executive Summary of the Assessment, EPA states that approximately 233,000 public comments were made on the first draft assessment. An additional approxim ately 83,000 comments have been made as of 19 May 2013 for the revised second draft of the Assessment, but only a little over 1,000 of these have been posted. The EPA says they will create a separate document providing responses to all comments which will accompany the final assessment when it is released later this year.

Based on a brief review of the posted comments, it is evident that more than 60 percent of the comments are from people who live in the lower 48 and are responding to letter writing campaigns from groups that are actively opposing the Pebble Mine.

Less than 9 percent of the comments are from Alaskans, and less than 2 percent stating they are of Alaskan Native heritage, suggesting that the comments on the whole are not representa tive of the stakeholder groups most likely to be affected by a potential project in this region.

Cumulative Impacts

As part of the Assessment, EPA identified 15 potential mineral deposits in the Bristol Bay Watershed. No mine plan has been put forth in relation to any of these deposits, so it is unrealistic to determine if cumulative effects of mining could be an unacceptable risk. Furthermore, it is important to note that the permitting of a single mine, such as the one described in the Assessment, would not guarantee that additional mines would also be permitted; any such additional mines would be subject to their own individual approvals processes.

On page 13-35 of the Assessment, the concern is raised about the Pacific Northwest and how traditional development patterns in Washington, Oregon, and Idaho have led to the near complete loss of wild salmon. To conclude based on the available information that the hypothetical mine scenarios put forward by EPA, along with the other listed deposits, could have a similar effect on the Bristol Bay fishery is not supportable.

Long-term, holistic approaches are essential if piecemeal decisions, which neglect cumulative impacts, are to be avoided. Consultative processes are important in order to address the concerns and optimize the outcomes. These are difficult decisions between development options and conservation objectives. Because no mine plan has been put forward and data and information is limited it is unrealistic that any conclusions can be made at this time. After any of these potential mine projects go through the NEPA EIS process then future potential mine projects would follow and have to go through the same rigorous (and always evolving) NEPA EIS process and be evaluated for cumulative impacts.

WATER QUALITY, FISH AND FISH HABITAT

The direct impacts from the hypothetical mine footprint are lumped with indirect impacts extending longitudinally downstream without proper analysis of indirect impacts (Section 7.2 Habitat Loss of the Assessment, pp. 7-15 through 7-33). For example, the Assessment conflates indirect impacts to aquatic habitats such as reduced surface water flows, off-channel habitat effects, modification to groundwater flow pathways, etc. into the same category as direct impacts associated with the mine footprint. In this manner, the Assessment wrongly avoids evaluation of the level of indirect impacts across a continuum with increasing distance downstream. Instead, the Assessment treats indirect impacts on par with direct impacts. This is evident

in the Assessment's analysis of stream habitat losses when it states, "A total of 8 km, 24 km and 35 km of documented anadromous fish streams would be eliminated, blocked, or dewatered by the mine footprints..." (p. 7-26). These stream lengths indicate the Assessment has lumped the indirect effects associated with dewatering with the stream reaches affected by direct impacts, resulting in an overestimate of habitat impacts. It is not reasonable to equate stream reaches with flow reductions as a 100 percent loss in habitat; anadromous fish will continue to use these reaches, and, in some cases, the habitat quality might be enhanced with appropriate targeting of water delivery to meet specific life history needs. As a result, the actual quantity/ length of anadromous stream habitat directly impacted by the hypothetical mine footprint would likely be less than the estimates provided by the Assessment.

The Assessment quantifies direct and indirect impacts to stream habitat as an absolute expressed in kilometers. The EPA neglects to account for on-site and off-site mitigation and enhancement measures the mine applicant would implement to offset direct impacts and minimize indirect effects. Reasonable mitigation measures that could comfortably be assumed as part of modern mine design might include a mitigation flow distribution plan including groundwater infiltration galleries, spawning channel and off-channel habitat construction, removal of fish barriers, and potential nutrient supplementation. In Box 7-2 of the Assessment, Compensatory Mitigation (p. 7-32), the EPA labels all mitigation as compensatory and challenges the efficacy of mitigation. Developing protection, mitigation, and enhancement measures is a fundamental step in the review process of any large project such as the mine scenarios considered in the Assessment. Failing to acknowledge protection, mitigation, and enhancement measures will be part of any mine application allows the EPA to assume a worst case scenario.

Section 7.3 – Stream Modification

This section describes indirect impacts from water withdrawals on stream flow conditions. Section 7.3 states a >20% reduction in stream flow for the PLP 0.25 scenario will result in a reduction in fish habitat of 15 km of stream reach. The Assessment's conclusions are based on scenarios that are not realistic and are not reflective of best available practices for flow mitigation. In addition, the scenarios are based on an analysis that does not utilize best practices in groundwater and surface water modeling which would be appropriate (and required) to permit the hypothetical mine (e.g. MODFLOW, PHABSIM, etc.).

Figure 7-1 (p. 7-3): Conceptual model illustrating potential linkages between sources associated with the mine scenario footprints, changes in physical habitat, and fish endpoints

The figure provides a conceptual model/ illustration of the potential impacts from the mine footprint on fish and fish habitat. The conceptual model/ illustration lacks two important elements: 1) a level identifying potential mitigation and enhancement measures that might be incorporated to minimize or, in some cases, eliminate impacts; and 2) an assessment of scale incorporating relative size of potential impacts with increasing distance from the mine footprint, further distinguished as direct vs. indirect impacts. The figure currently lacks a context for the spatial scale of these potential impacts.

In contrast, a more appropriate conceptual model would identify both direct and indirect impacts along with state of the art mitigation measures including habitat replacement and enhancement along with the associated long-term maintenance of those habitats as mitigation. Examples of well accepted habitat replacement measures include engineered stream channels for spawning and rearing, construction of ponds for rearing, flow mitigation infiltration galleries, connectivity to off-channel habitat, removing fish passage barriers and implementation of a water management plan designed to enhance fish habitat suitability with controlled flow releases. In addition, avoidance of critical habitats where possible is standard practice. The Assessment's conceptual model fails to acknowledge implementation of Best Practice Management Plans and ignores existence of mitigation and enhancement measures designed to minimize or eliminate impacts to fish habitat.

Figures 7-2 through 7-8: Anadromous and Resident Fish Distributions from ADFG fish distribution catalogue

The distribution of sockeye and coho in the South Fork Koktuli appears to be a relatively liberal interpretation of upstream extent of fish distribution, but it is difficult to distinguish the exact location of Frying Pan Lake in the Assessment's figures. Sockeye should not be found upstream of Frying Pan Lake. In addition, the distribution of chinook in all three watersheds does not reflect current data on chinook as understood by PLP's baseline data and impact analysis.

Spawner Index Counts (Chapter 7 p.12):

> Between 1955 and 2011, sockeye salmon counts in Upper Talarik Creek have ranged from 0 to 70,600, with an average of 7,021 over 49 count periods (Morstad pers. comm.). Between 1967 and 2009, chinook salmon counts in the Koktuli River ranged from 240 to 10,620, with an average of 3,828 over 29 count periods. (Dye and Schwanke 2009)

Discussing these statistics in the absence of the total number of sockeye salmon in the Mulchatna, Nushagak, and wider Bristol Bay Watersheds fails to provide the appropriate context to understand the spatial scale involved and does not consider the detailed fish/ habitat data found in the EBD (PLP 2012).

Risk Characterization (Section 7.2.4):

On page 7-31 the Assessment characterizes the risks that would occur due to "direct loss or blockage of these streams" as "...leading to losses of local, unique populations [that] would erode the population diversity that is key to the stability of the overall Bristol Bay salmon fishery." (Schindler et al. 2010)

The Assessment's lumping of direct and indirect impacts into a cumulative estimate of stream reach loss, coupled with statements about the uniqueness and importance of salmon stocks in the hypothetical mine area that are critical to the Bristol Bay salmon fishery, is flawed and lacks documentation. The issues with lumping direct and indirect impacts are discussed above. And there is no basis to assume that the stream habitat directly and indirectly impacted by the hypothetical mine footprint should be weighted as more important than other anadromous salmon habitat in the Nushagak and Kvichak watersheds. The risk characterization should treat this anadromous habitat equally in the Assessment.

Furthermore, suggesting that the reaches directly affected by the hypothetical mine area support unique salmon stocks that are critical to the future of the Bristol Bay fish populations is not supported by the Assessment or any other report publically available. Assertions that sockeye utilizing habitat in the proposed mine footprint are demonstrably unique and critical for the stability of the overall Bristol Bay sockeye fishery are unfounded. The Assessment has not presented data demonstrating that the sockeye returning to the mine footprint area or the North and South Forks of the Koktuli are phenotypically or genotypically unique relative to other populations in the Nushagak-

Mulchatna system. The life history variations, including the run timing for sockeye distributed in the forks of the Koktuli and Upper Talarik, are similar longitudinally in the system, suggesting that these fish do not represent a distinct genetic group but more likely represent an upstream component of a larger riverine population. Thus, it does not logically follow, as the Assessment suggests, that the Bristol Bay sockeye salmon population and fishery would be dependent upon these relatively small components of larger populations.

Table 7-19 (p. 7-50):

The analysis of this table is flawed. The Assessment claims the hypothetical mine scenarios will result in a 20% stream flow reduction. The table is not transparent with respect to the method for calculating the impact percentage for respective streams. Even assuming one accepts this 20% reduction, the resulting length of stream affected by the stream flow reduction is over estimated. The Assessment does not make it clear that a 20% reduction in flow does not necessarily correspond to a 20% reduction in habitat.

Discussion of Fish and Fish Habitat Related to Toxicity

Chapter 3, baseline physical and chemistry data on water bodies, is presented in the Assessment as a very limited data set. As a key component of an ERA under the EPA framework (1992 and 1998), a robust and detailed understanding of baseline conditions is essential in determining risk. Subsequent conclusions on chemical changes in water chemistry are therefore speculative without a broader watershed-wide baseline characterization.

The document takes great effort to reference the PLP EBD report, which shows locations where PLP has identified elevated copper concentrations in headwaters near the Pebble deposit. What is not discussed in the Assessment is that these are the very waters where the Assessment predicts impacts to native fish and invertebrate populations as a result of changes in water quality because of the hypothetical mine scenario. However, these resources do not show signs of impairment from these copper concentrations in the absence of any other input. This shows evidence of naturally-elevated copper (and other metals) levels in the stream reaches near natural deposits, which are apparently not contributing to impairment of the streams.

The EPA relies on the use of the Biotic Ligand Model (BLM) for derivation of water quality criteria. This is the preferred approach, but to fully understand

the model output, further review of the model inputs, assumptions, and data are necessary to evaluate the derived criteria.

The Assessment relies on some references that are far reaching. For example the statements related to sub-lethal effects of copper and wide-ranging population level effects are not generally supported in the scientific literature.

The evaluation of sediment toxicity relies heavily on benchmarks such as the TEL/ PEL values presented by McDonald (2000). Typically, an exceedance of these values would trigger a further site investigation to understand the exact nature of site-specific conditions and the resulting toxicity. These values should be characterized as those that would trigger further work, not conclusions on toxicity themselves.

As mentioned above, the Assessment establishes as an endpoint to assess the abundance, productivity, or diversity of the region's Pacific salmon and other fish populations. However, the Assessment fails to actually analyze this endpoint qualitatively. Instead, it simply talks about impacts to fish habitat and wetlands.

For example, regarding sockeye salmon, the average annual inshore run of sockeye salmon (the key fish species identified in the Assessment) in Bristol Bay was 37.5 million fish between 1990 and 2009 (p. 5-11). Based on the highest index spawner count over the 5 year survey period, approximately 90,200 sockeye salmon were estimated in the Mine Scenario watersheds, (which include the South and North Fork Koktuli Rivers and the Upper Talarik Creek, Table 7-1 on p. 7-13). Accepting that this estimate may underestimate the actual population, these fish represent about 0.25% of just the returning sockeye salmon in the Bristol Bay watershed, and certainly a much lower percentage of the total population. Although this is a crude estimate, it provides an order of magnitude sense of the potential project effect on fish populations, which the Assessment fails to provide.

The Assessment describes the Bristol Bay sockeye salmon fishery as the largest in the world (46% of world population of sockeye). It is unclear from the Assessment what EPA's assumptions are regarding the percentage of sockeye production comes directly from the South and North Fork Koktuli, or the Upper Talarik. Furthermore it is unclear if within this region the values presented in the Assessment are intended to represent annual or inter-annual variation. ERM's analysis (see Tables 1 and 2 and related discussion above) indicates that the number of sockeye produced by the North Fork Koktuli (as well as the South Fork Koktuli and Upper Talarik Creek) in comparison to the

total district inshore run for the Nushagak and Naknek-Kvichak systems, is very low. When compared to overall Bristol Bay production, the proportion attributable to sockeye production by the three drainages is near zero. This is not to suggest that these fish are not important, but only that they represent a small fraction of overall production, and are nominal in comparison to the annual Bristol Bay commercial harvest (25 to 30 million sockeye commercially harvested annually). Implying, as the Assessment does, that the loss of stream habitat in these drainages will have a net effect on sockeye numbers at the Bristol Bay scale is not supported by the data.

The Assessment describes the chinook salmon returns in the Nushagak River as averaging over 100,000 individuals per year. The analysis presented in the Assessment is incomplete and misleading in that it fails to recognize that the North and South Forks of the Koktuli River (tributaries of the Nushagak) and other reaches within the immediate area of the hypothetical mine location are relatively minor contributors to the overall Nushagak River chinook salmon production. The North and South Forks of the Koktuli River (tributaries of the Mulchatna River, a major Nushagak River tributary) are relatively minor contributors to overall Nushagak River chinook salmon production. Specifically, as discussed above, the percentages of the Nushagak watershed's annual return of sockeye salmon and commercial catch of sockeye salmon attributed to the North Fork Koktuli are 1.5% and 0.1%, respectively, and to the South Fork Koktuli are 4.5% and 0.2%, respectively.

Sections 5 and 7 present evidence of the loss of fish and fish habitat due to reduced water availability to stream flow and direct impacts on habitat. While under the scenarios presented in the Assessment this may be true, a complete analysis is not presented.

Throughout the Assessment, statements are made that appear to cross multiple spatial scales. For example, the conceptual site models presented for salmon impacts do not reflect the different spatial scales of impacts. Furthermore, the footprint of the mine evaluated for spatial impacts reflects those of a hypothetical mine scenario rather than an actual project description, so any conclusions on this scale are inherently not accurate.

The Assessment relies on Alaska Department of Fish and Game analysis on yield to establish sustainable levels. These data are obtained from observer reports of escapement. It is unclear in the Assessment what defines sustainable harvests. Furthermore, it is not clear what level of industrial fishing is necessary, if any, to influence the sustainability of salmon stocks. Furthermore, the commercial sockeye fishery in Bristol Bay is sustained

because of regulations limiting the commercial harvest allowing a sufficient number of adults to spawn, to protect future harvests. In the absence of those regulations, commercial fishing would likely proceed at an accelerated rate congruent with market demand and likely resulting in overharvest. The Assessment fails to point out that the Bristol Bay sockeye industry has sustained itself because of these regulatory limits. Like the commercial fishing industry, a mine of the caliber discussed in the Assessment would certainly go through a robust regulatory review process whereby management conditions would be established in a fashion that makes the mine development compatible with other resource uses.

PIPELINE RELEASE SCENARIO AND ASSOCIATED FATE AND TRANSPORT ANALYSIS

Overstatement of Spill Probability

The pipeline spill probability assessment inaccurately correlates Pipeline and Hazardous Materials Safety Administration (USA) and Energy and Utilities Board (Canada) pipeline incident data to a full-bore rupture release of a 20 centimeter, double-walled pipeline. Both datasets document all reported incidents from leaks to ruptures for all causes (e.g. corrosion, third–party damage). Therefore, a frequency value derived using all incidents will be biased toward the incidents that populate the database the most. In both databases, small volume releases from leaks represent nearly 80% of the reported incidents. Full-bore ruptures represent a much lower population in the databases. An appropriate frequency value for the pipeline scenarios should be based upon the frequency of full bore ruptures so that a representative comparison can be made to the presented scenario. If done, it is likely that the frequency of occurrence will be lower than established in the Assessment. Similarly, the causes of release are qualitatively used in the evaluation. Release frequency based on cause can be established, which would then assist in identifying the applicable threats of a release. Finally, EPA's scenario assumes that a double-walled pipeline will be used (Section 6.1.3.2) for above ground pipe. Modification factors for this mitigation measure would further reduce the release frequency for the evaluation. So, because a generic frequency value has been used and not adjusted for release type, cause(s), and mitigation measures, the frequency used in the report overestimates the likelihood of a full-bore release from the pipeline. In addition, the report does not state whether the pipeline is operated 24/7 or at specific times or intervals.

Lack of Key Parameters for Release Scenario

The report analysis assesses a release from a full-bore rupture. It describes in general terms that a release volume is affected by the shutdown time of remote valves and the draindown of the pipeline. These parameters are the basis of the volume of slurry released from the pipeline, the related mass of concentrate transported to the downstream water bodies, and the resulting effect on salmonids. The report does not provide key parameters to technically evaluate the accuracy of the mass estimate and the reasonableness of the consequence evaluation. Parameters that could not be readily discernible in the report are pump flow rate, length of pipeline under draindown, and the time of draindown. Showing these parameters would allow a critical assessment of the volume released under pumping conditions before remote valve isolation, the volume drained under gravity, the length of pipeline under draindown, and the time for the pipeline to drain under gravity.

Calculation of Impacts Related to Release Scenarios

The report identifies that 67 tons of concentrate will travel down Chinkelyes Creek and 24 tons of concentrate will travel down Knutson Creek and that the travel time will be 240 minutes and 24 minutes, respectively, until it reaches Iliamna Lake. The hydrology assessment using a precipitation model and culvert analysis is a very simplistic approach to estimating sediment transport in stream channel conditions, and could easily be predicting a travel time that would be much quicker than actual for the mass reaching the water bodies. Since all the mass is not released as a single slug, the duration of the release also should be incorporated in the fate and transport evaluation so that the hydrology of the spill volume can be critically evaluated. In addition, the travel time appears to represent the time for water to travel from the release point to the receptor. The report qualitatively acknowledges that the density of the slurry plays a role in how it is transported, but this was not taken into account when calculating the arrival time, and the rate at which the mass would be introduced to the water body. Finally, the total time for slurry mass to enter the water body would allow for a refined assessment of the consequence of the release. Providing the arrival time of the aqueous phase of the release loses the benefit of fully understanding the dynamics of the release into the receiving water body. The flow model should address slurry characteristics, surface roughness, duration of the spill volume and channel geometry as a more appropriate screening approach that is consistent with the scenarios.

WILDLIFE ABUNDANCE, SUBSISTENCE USE, AND SOCIO-ECONOMICS

General Comments

The report largely fails to capture, in a balanced perspective, both the positive and negative impacts related to subsistence use and socio-economics as they relate to potential mining activities in the study area. Qualitative analysis of positive comments about potential for employment and increased infrastructure availability is present but very limited. Most of the qualitative discussion concentrates on the perceived negative impacts to subsistence use in terms of livelihoods, diet, and related cultural effects. The analysis presented, however, does not consider the positive benefits that responsible mineral development could deliver to a relatively remote region with little developed infrastructure and services, particularly one which has been suffering from out-migration and high unemployment for some time.

To this point, the Executive Summary states that, "This assessment does not consider all impacts associated with future large-scale mining in the Bristol Bay watershed". This is true particularly of the potential positive impacts on socio-economics, as well as to a lesser extent on subsistence use. An example of a positive socio-economic aspect is mentioned on page ES-4 of the Assessment: "However, it is recognized that a large-scale mine development could induce the development of additional support services for mine employees and their families, recreational facilities due to increased access, vacation homes, and transportation infrastructure beyond the main corridor (i.e., airports, docks, and roads)". While this is a valid point, it is not discussed at length in the Assessment. Instead, the Assessment leaves the impression that any economic benefits will be limited. The Assessment also focuses on the generally negative assumed socio-economic impacts on the commercial salmon fisheries, and does not analyze positive impacts of mining employment and contracting to the same degree.

Some comparisons to other mines in northern and western Alaska have been made. However, the material presented is largely negative. More detailed and balanced information on mines in Alaska such as Red Dog and oil and gas development studies on the North Slope would be useful to more accurately demonstrate and predict how subsistence practices will change with mining development and perceived impacts. In the Assessment, more comparative material on other mining and oil and gas projects has been provided. However, this material is limited in volume (pp. 12-9 and 12-10).

The main deficiencies for subsistence use and socio-economics are presented below under the subheadings of Demographics, Economics and Employment, Infrastructure and Services, Subsistence Use, Uncertainties and Definitional Clarity.

Effects on Wildlife and Native Alaska Cultures

The Assessment links impacts to salmon populations to wildlife populations, but acknowledges that impacts cannot be quantified on page 12-1 of the Assessment: "Lower salmon production would likely reduce the abundance and production of wildlife in the mine area and presumably in the range areas of the affected species, but the magnitude of those effects cannot be quantified." Nevertheless, the Assessment states that "...on a cultural level, a significant loss of salmon would result in negative stress on a culture that is highly reliant on this resource" (p. 12-13) without defining what "a significant" loss would be. Without comparing baseline salmon and wildlife populations to current subsistence gathering levels, and evaluating how Project related impacts would affect those populations (i.e. evaluating if the impact is significant or not), the Assessments is simply conjecturing about potential impacts to wildlife and Native Alaskan cultures without substantiating them.

Demographics

With the exception of a few of tables in Appendix E of the Assessment, Bristol Bay Wild Salmon Ecosystem Baseline Levels of Economic Activity and Values (p. 29-30, 1.2 Definition of Study Area), very limited information has been provided on the demographics of the region and its communities. There is no information on changes to human population levels over time, including growth or decline as a consequence of birth and death rates and in- and out-migration rates. It is not possible to assess impacts on socio-economics or subsistence use without understanding the local and regional population dynamics. The Assessment fails to report that statistics show that the Lake & Peninsula Borough has a low and declining population (in 2009, the population was 1,547, down 11 percent from 2000). For a comprehensive assessment of impacts to these components, this type of information is required, as is a discussion on relevant findings such as population decline. There is also no information presented on the historical labor profile of the study area, including trend lines of the past 10 years minimum for employment/ unemployment/ underemployment and earnings.

Economics and Employment

The only economic information discussed is for the commercial salmon industry, and to a lesser extent, sport fishing and subsistence fishing. The predicted economic effects of mining are not assessed at all. Direct (mainly positive) impacts of the mine through jobs and opportunities for regional and local development are also not discussed, and are critical to understanding the overall potential impact of mine development and its associated activities on Native Alaskans. These aspects of the development of a project like the hypothetical mine scenario are discussed in the May 2013 study entitled *The Economic and Employment Contributions of a Conceptual Pebble Mine to the Alaska and United States Economies* (IHS 2003).

On page 12-11, citing Goldsmith (2007) it is mentioned that, "Although large-scale mining would inject some market-based economic benefits for a period, it would likely have only modest direct employment benefits in the local region, based on resource extraction experiences in other rural Alaska areas". The comparison made to Red Dog Mine is largely negative, stating that the Northwest Alaska Natives (NANA) Regional Corporation shareholders disproportionately hold the mine's lower-skilled positions, and that employment at the Red Dog Mine may have facilitated community residents to relocate to Anchorage for lifestyle or economic reasons. Although it is mentioned that NANA shareholders accounted for approximately 56% of the mine's 464 full-time employees and 91% of the 78 part-time employees, this is not commented on as a major direct benefit to the region. Even lower-skilled positions in the mining sector are typified by higher than average wages. Increased household income would also be expected to occur in communities throughout the Bristol Bay study area due to increased economic activity in key economic sectors.

No analysis has been conducted on predicted taxes and revenues to state and local governments as a result of the Pebble Mine. The Project would pay state mining license taxes, Alaska corporate income taxes, state royalties, and local severance taxes. Taxes are discussed only in reference to the Bristol Bay salmon fishery.

Infrastructure and Services

Very little to no information has been provided on local and regional infrastructure and services except in the context of induced development, which is depicted in a mainly negative light. A fulsome analysis in the socio-economic section would require a discussion of the context of the availability and capacity of existing social and health infrastructure and services, including schools, health clinics/ hospitals, emergency services, utilities, and government, among others. Similar to demographics, it is not possible to

assess impacts on socio-economics without first characterizing infrastructure and services at a baseline level.

Several other economic and social benefits could have been more thoroughly discussed. For example, improved and new road and airport access in the area could give some residents better access to services and goods that previously were difficult to obtain, either by short-term winter road or by air.

Subsistence Use

Subsistence use in the Assessment focuses predominately on salmon fishing, with many of the other kinds of subsistence use activities not discussed.

Impacts on time available for subsistence use by those employed in mining are not well analyzed. More emphasis should have been paid to the trade-offs associated with subsistence use and employment in mining. For example, in Chapter 12: Fish Mediated Effects (p. 12-12) the EPA states that, "Some of the companies did not have subsistence leave policies, so workers conducted subsistence activities during their weeks off or would take personal time. Where the companies did have policies for subsistence leave, an average of 46% of respondents were unsure whether or not the policy worked". However, experience from diamond and other mines in northern Canada, for example, have shown that time available to harvest and process subsistence resources for those working in mining may be less affected than initially assumed. For example, those employed or contracted could have more time for subsistence use harvesting as a result of favorable rotational periods. Also, more income will enable harvesters to purchase better equipment, enabling them to be more time efficient. Workers with more disposable cash will have the ability to purchase more amenities such as vehicles and recreational vehicles for pursuing traditional cultural activities, such as trapping and hunting. They may make improvements to their housing or the quality of food and clothing. Additional income and time off during the long rest periods could allow some workers from the villages to engage more in traditional activities, including hunting, fishing, and trapping. Without discussion of these tradeoffs, the Assessment fails to capture the full spectrum of positive and negative impacts to subsistence users, and thus fails to accurately characterize impacts to this population.

Experience on impact assessments of similar kinds of projects indicates that the application of a wide range of prediction methods, including quantitative, semi-quantitative, and qualitative techniques, can help evaluate to which degree an impact or effect is expected to occur as a result of an unplanned

event (uncertainty), or more simply the degree to which the unplanned event is expected to occur (likelihood). Some impacts will definitely occur, and others may or may not occur, depending on various factors which need to be identified and analyzed.

> The actual response of Alaska Native cultures to any impacts of the mine scenarios is uncertain. Interviews with village Elders and culture bearers and other evidence suggest that responses would involve more than the need to compensate for lost food, and would likely include some degree of cultural disruption. It is not possible to predict specific changes in demographics, cultural practices, or physical and mental health.

Because the Assessment lacks sufficient analysis, much of EPA's discussion on the impacts to subsistence users is speculative. For example, in Section 12.2.1 Subsistence Use (p. 12-9) the EPA states that, "It is not possible to predict the magnitude of effects from the loss of salmon as a subsistence food, nor is it possible to predict what level of subsistence resource loss would be necessary to overcome the adaptive capacity of these cultures". Based on this conclusion, it necessarily follows that definitive statements of significance cannot be made regarding the negative impacts. Yet, the term "significance" is often used in the Assessment to indicate definitive assessments have been made, which is misleading.

In Section 14 Integrated Risk Characterization, the Assessment provides a summary of uncertainties and limitations. In effect, doubt is placed on the entire analysis for effects to subsistence use and socio-economics. For example, on page 14-14:

The same comment applies to cultural practices, or physical and mental health. The authors have largely dismissed standard social and cultural heritage impact analysis and assessment techniques, and in so doing have thrown doubt on any assertions they have made concerning the responsiveness or adaptability of Alaska Native cultures to mine scenario impacts.

Definitional Clarity

There are numerous mentions of "sustainable fishing" in the Bristol Bay watershed for commercial, sports and subsistence fishing. For example, Appendix E of the Assessment (p. 10) states that "the existing mainstays of the economy in this region are all wilderness-compatible and sustainable in the

long run: subsistence use, commercial fishing, and wilderness sport fishing, hunting, and wildlife viewing and other non-consumptive recreation. Commercial fishing is largely in the salt water outside of the rivers themselves and is closely managed for sustainability. The subsistence, sport fish and other recreation sectors are relatively low impact (primarily personal use and catch and release fishing, respectively)." No explanation is provided as to how "low impact" was determined. The Assessment appears to be using the term "sustainable fishing" rhetorically based on the fact that the Bristol Bay fishery has supported the industry and subsistence cultures for many years. Criteria for measuring whether this can be maintained with various projects on the landscape appear not to have been presented in the Assessment.

COMMUNITY HEALTH

In *Chapter 12 – Fish-Mediated Effects*, the Assessment incorporates discussions on human health effects as part of a range of impacts on Alaska Native cultures from changes to the salmon resources.

The qualitative assessment lacks a systematic methodology for robustly evaluating health impacts related to a major mine project scenario. The specific scenario for assessing the impacts on Alaska Native cultures is unclear and inconsistent. On one hand, the EPA states in Chapter 12.3 Uncertainties (p. 12-3) that the assessment "represents a conservative estimate of how these endpoints could be affected by mine development and routine operations". But throughout Chapter 12, the EPA discusses that human health and cultural effects would be significant in the context of a major non-routine event scenario, as described by phrases such as "large-scale releases"; "loss of salmon"; "significant reduction in salmon quality or quantity"; and "accidents and failures associated with large-scale mining".

As the primary basis for identifying health effects, the Assessment references accounts of health issues documented in *Appendix D – Traditional Ecological Knowledge and Characterization of the Indigenous Cultures of the Nushagak and Kvichak Watersheds, Alaska* and studies/ reports on other industrial development in Alaska (i.e., Red Dog Mine, oil and gas activity in the North Slope, and Exxon Valdez oil spill). Although these referenced studies/ reports have limited comparability to the type of mine project upon which the Assessment is based, the Assessment inappropriately asserts with high confidence that "other studies related to resource extraction industries (North Slope, Red Dog Mine) or environmental contamination (Exxon Valdez) in Alaska confirm that there certainly would be changes in human health and

Alaska Native cultures" (Chapter 12.3 Uncertainties, p. 12-17). In actuality, the conclusion of a definite change in human health, specifically physical health, is not supported by the referenced studies/ reports on the North Slope and Red Dog Mine. In the NRC (2003) study on Cumulative Effects of Oil and Gas in the North Slope, the "increased incidence of cancer and diabetes" was not based on epidemiological evidence, but rather on input by North Slope residents. And quantitative risk assessments on the Red Dog Mine by ADHSS (2001) concluded that heavy metal concentrations in drinking water and in subsistence foods were within acceptable limits and did not pose a health risk.

Overall, the Assessment is deficient in that it lacks a baseline context (i.e., pre-mine context) as a reference point for determining potential changes in human health at the community level. For instance, published public health data indicate that the Bristol Bay Region currently has high burdens of nutrition-related health problems (e.g., obesity and diabetes) and chronic diseases (e.g., heart disease and cancer) (UW's County Health Rankings, 2012; ANTHC, 2008). Furthermore, the Assessment asserts an oversimplified pathway of health effect that does not take into account existing modifiable risk factors (such as alcohol use, smoking, lack of access to fresh vegetables, consumption of sugary beverages, etc.) that influence the physical health of the individual and community. Without accounting for these various factors that contribute collectively to human health, the Assessment is inaccurate in asserting a high certainty for anticipating changes in physical human health effects (e.g., nutrition-related diseases) from the hypothetical mine scenario.

Lastly, the Assessment lacks appropriate or representative assumptions that would provide a more balanced view of the potential health and cultural effects. For instance, the Assessment asserts in Chapter 12.2 Effects on Alaska Natives (p. 12-6) that "A shift from part-time to full-time wage employment in mining or mine-associated jobs would affect subsistence-gathering capabilities by reducing the time available to harvest and process subsistence resources". This provides an imbalanced assessment because it does not take into account the positive effects of cash income from employment on a community's overall subsistence-gathering capabilities, as well as, harvest-sharing capabilities; cash income from employment is often used for costly subsistence inputs (i.e., gasoline, boats, snow machines, ammunition, etc.) according to Kerkvliet, JNW (1997). In addition, the Assessment does not consider subsistence leave policies for local employed residents, which is an industry best practice to provide flexible work schedules to accommodate subsistence harvest periods. Overall, the Assessment lacks discussion of potential positive effects associated with industrial development, which were reported by North Slope residents as documented in the NRC 2003 study.

Following this letter please find two attachments, ERM's Summary Comments on the Bristol Bay Assessment, and curriculum vitae for our subject matter experts. If you have any questions regarding our comments presented herein, please feel free to contact me at your convenience at todd.hall@erm.com.

Sincerely,

Environmental Resources Management

all
Partner
Impact Assessment & Planning
The Americas

Page	Section	Excerpt	Contributor	Technical Comment	Citations	General Subject Area	Comment Category
	Abstract	General	ERM	The Abstract does not summarize the report accurately, is vague and leads to more questions than it answers because the specifics are yet unknown and too early in the mine planning process to make any sound conclusions		Hypothetical Mine/Premature Assessment	Information is presented out of context or in a misleading way.
	Abstract	"evaluates the potential impacts of large scale mining development"	ERM	The Executive Summary of the Assessment states that it, "...evaluates the potential impacts of large-scale mining development on salmon and other fish populations, wildlife, and Alaska native cultures..." and that it was, "...conducted as an ecological risk assessment...". An Ecological Risk Assessment (ERA), by its very nature, is a scientific analysis of ecological resources, and its scope (by design) excludes many considerations related to the effects of development of mineral resources in Alaska. To this point, the scope of the Assessment, as defined by EPA, excludes many stakeholders from a robust public participation process. The EPA's claim that the Assessment is an ERA notwithstanding, the Assessment includes elements of both an ERA and an Environmental Impact Assessment (EIA), but the Assessment is not a comprehensive example of either.		Assessment/Report Structure	Information is presented out of context or in a misleading way.
	Abstract	"developed realistic mine scenarios"	ERM	Without ore and production rates stated, it is difficult for the reader to establish how "realistic" is defined.		Mine Scenarios	Conclusions are based on unrealistic or non-representative assumptions.
	Abstract	"we conclude that mining would, at a minimum, cause the loss of spawning and rearing habitat for multiple salmonids."	ERM	The abstract states that the mine footprint scenarios would result in the direct loss of 38, 90 and 145 km of streams and 5, 12.4, 19.4 sq km of wetlands but does not mention that Bristol Bay Watershed is 115,500 sq km in size, or that the Nushagak and Kvichak River watersheds are 59,890 sq km in size.		Fish and Fish habitat	Information is presented out of context or in a misleading way.
	Abstract	water withdrawals would significantly diminish 15, 26 and 54 km of streams	ERM	The abstract does not account for any mitigation measures that could be available to reduce these impacts.		Mitigation	Conclusions are based on unrealistic or non-representative assumptions.
	Abstract	"reasonable upper bound failure scenario"	ERM	This scenario is flawed. If the treatment plant fails, then a typical best practice design would redirect the discharge to the tailings storage facility.		Mine Scenarios	Conclusions are based on unrealistic or non-representative assumptions.
	Abstract	culvert failures could... tailings failures could... spill of concentrate.... etc	ERM	The abstract does not sufficiently state the fact that these failure scenarios are "low probability" events, so the risk (a factor of probability and consequence) are easily taken out of context.		Mine Scenarios	Information is presented out of context or in a misleading way.
3-28	3.5 Water Chemistry	The watersheds in the Pebble deposit area (Figure 2-5) are neutral to slightly acidic, with low conductivity, hardness, dissolved solids, suspended solids, and dissolved organic carbon (Table 3-4)	ERM	Water chemistry data is only referenced from the PLP 2011 Environmental Baseline Document. No chemical data are presented, and the only data are referred to as "elevated", again with the PLP reference. Much of the Assessment is focused on ecological effects of chemistry and the accurate baseline is not presented in this document. Additionally, there is no comprehensive baseline data set presented for the Bristol Bay Watershed, only the Mine project area. Predicting impacts without due consideration of baseline conditions will result in non representative impacts being predicted.	PLP 2011 EBD	Water Chemistry Baseline	Incomplete data set

Page	Section	Excerpt	Contributor	Technical Comment	Citations	General Subject Area	Comment Category
3-31	3.6 Water Temperature	Water temperature data (PLP 2011: Appendix 15.1E, Attachment 1) indicate significant spatial variability in thermal regimes	ERM	Baseline water temperature data are only referenced from the 2011 PLP EBD. No new data are presented, and broader BBWA-wide data are not presented.	PLP 2011 EBD	Water Temperature Baseline	Incomplete data set
4.6	4.2.2	The pyrite-poor, low-grade core corresponds to the central part of the Bingham Canyon deposit, where NNP values are greater than zero. Moving outward from the core to the ore shell and pyrite shell, pyrite abundance increases and NNP values become progressively more negative (Figure 4 2[B]).	ERM	The comparison to the geological structure of the Bingham Canyon deposit is not explained. The implication is that the Pebble deposit is similarly structured in terms of pyrite distribution although that comparison and the implications of that layout are not explained. The implication could be that the problem of ARD would be worse the farther out from the core of the deposit the ore/waste is taken (until the eventual drop off in pyrite concentration).		Geology/ARD	Possible incorrect reference to another deposit style leading to poor assumptions about distribution of pyrite (and therefore ARD) across the orebody.
Section 5	Section 5	The Assessment indicates throughout that overall salmon populations are expected to be reduced due to water looss and direct impacts.	ERM	Data indicating significance/non significance are not currently available since population studies on the local drainages have not been conducted, and only abundance studies have been reported. The Assessment fails to substantiate statements on reduced salmon populations with references supporting their position. Furthermore, the Assessment fails to distinguish between spatial scales when making these statements. Anadromous stream lengths in the three watersheds (South and North Forks of Koktuli and the Upper Talarik) comprise less than 0.3 % of the total anadromous stream length in the Nushagak and Kvichak river systems and still less for the six combined hydrologic units comprising Bristol Bay. In addition, adult sockeye return estimates for these three watersheds are less than 0.2% of the total commercial harvest in Bristol Bay. In fact, the interannual variation in Bristol Bay commercial harvest is greater than the annual return estimates for the Koktuli Rivers and the Upper Talarik. In summary, the existing data sets indicate reductions in salmon populations will likely not be measurable at the Bristol Bay Scale.	No reference provided	Fish and Fish Habitat	Scale of impact
5-11	5.2.2.1 Salmon	Sockeye is by far the most abundant salmon species in the Bristol Bay watershed (Table 5-3) (Salomone et al. 2011). Bristol Bay is home to the largest sockeye salmon fishery in the world, with 46% of the average global abundance of wild sockeye salmon between 1956 and 2005 (Figure 5-9A) (Ruggerone et al. 2010). Between 1990 and 2009, the average annual inshore run of sockeye salmon in Bristol Bay was approximately 37.5 million fish (ranging from a low of 16.8 million in 2002 to a high of 60.7 million in 1995) (Salomone et al. 2011). Annual commercial harvest of sockeye over this period averaged 25.7 million fish (Table 5-3), and 78% of the average annual subsistence salmon harvest (140,767 salmon) over this period were sockeye (Dye and Schwanke 2009, Salomone et al. 2011). Escapement goals—that is, the number of individuals allowed to escape the fishery and spawn, to ensure long term sustainability of the stock—vary by species and stock. For example, the current sockeye escapement goal for the Kvichak River ranged from 2 to 10 million fish (Box 5-2). Annual sport harvest of sockeye in recent years has ranged from approximately 8,000 to 23,000 fish (Dye and Schwanke 2009).	ERM	The Assessment describes the Bristol Bay Sockeye Salmon fishery as the largest in the world (46% of world populations of Sockeye). It is unclear from the Assessment what percentage of sockeye production come directly from the Koktuli's South and North Forks, or the Upper Tularik. Furthermore it is unclear if within this region the values presented in the report are annual or interannual variation. ERM's analysis indicate that the number of sockeye produced by the North Koktuli (as well as the South fork and Upper Talarik Creek) in comparison to the total district inshore run for the Nushagak and Naknek-Kvichak systems is very low. When compared to overall Bristol Bay production the proportion attributable to sockeye production by the three drainages is near zero. This is not to suggest that these fish are not important but only that they represent a negligible fraction of overall production, and are negligible in comparison to the annual Bristol Bay commercial harvest (25 to 30 million sockeye commercially harvested annually).	Morstad et al., 2010, as cited by PLP EBD 2011; Baker et al., 2009, as cited by PLP EBD 2011	Sockeye Salmon Fish and Fish Habitat	Incomplte use of data and incomplete analysis

Page	Section	Excerpt	Contributor	Technical Comment	Citations	General Subject Area	Comment Category
5-13	5.2.2.1 Salmon	Chinook salmon are an important subsistence food for residents of the Nushagak River watershed. Chinook returns to the Nushagak River are consistently greater than 100,000 fish per year, and have exceeded 200,000 fish per year in 11 years between 1966 and 2010. This frequently places the Nushagak at or near the size of the world's largest Chinook runs, which is notable given the Nushagak River's small watershed area compared to other Chinook producing rivers such as the Yukon, Kuskokwim, Fraser, and Columbia.	ERM	Among the three local drainages where direct impacts will occur, the NFK supports the largest run of Chinook salmon (followed by the SFK), and indeed Chinook were the most abundant of any salmon in the NFK in 2004 and 2005. That changed in 2006 when the run decreased by an order of magnitude confirming that a high interannual variability exists in these stream systems. Between 2004 and 2008 the Nushagak River Chinook salmon escapement estimate ranged from 53,344 in 2007 to 163,506 in 2005 and had a 5-year average of 106,131 (Baker et al. 2009; as cited by PLP EBD 2011). In contrast, the NFK Chinook salmon mean index counts (used as an index of escapement) ranged from 157 in 2008 to 1,838 in 2004 and averaged 891 for the 5 year study period (PLP EBD 2011; Table 15.1; Figure 15.1-27). The North and South Forks of the Koktuli River (tributaries of the Mulchatna River, a major Nushagak River tributary) are relatively minor contributors to overall Nushagak river Chinook salmon production. There are many Mulchatna and Nushagak River tributaries that likely produce much greater numbers of Chinook salmon (although further analysis is needed to confirm this and relevant data is limited for some stream systems and sub-tributaries). These include the Wood River, Kokwok River, Mulchatna River, Nuyakuk River, Tikchik River and the King Salmon River (Nushagak Tributaries) and the Stuyahock and Chilikadrotna River (Muchatna Tributaries).	No reference provided	Chinook Salmon Fish and Fish Habitat	Data not supported by reference. Incomplete use of data and incomplte analysis
6-13	6.1.2.5	The cone of depression would lower the groundwater table, drying up streams, ponds, and wetlands that depend on groundwater discharge and turning areas of groundwater discharge into areas of groundwater recharge.	ERM	Assumes direct and complete connection between surface (ie precipitation) and underlying groundwater so potential impacts are likely exaggerated.		Water Management/ Treatment	Water Management
6-19	6.1.3.2	Any aboveground pipeline sections would be constructed of double walled pipe.	ERM	The frequency data used in the cited references were developed using PHMSA's and EUB pipeline incident dataset. The entire dataset includes releases from all reported spill volumes ranging from leaks to ruptures and all pipeline diameters. The scenario presented also describes the use of double-walled pipelines. The use of frequency data for all incidents rather than for a full bore rupture with a double-walled construction, as described in the scenario, overestimates the likelihood of a spill and is overly conservative for the presented scenario. The impact analysis should be consistent with that scenario presented and should be based on a dataset for double-walled pipelines that resulted in a full bore rupture. The resulting release frequency based on this subset of the PHMSA and EUB dataset would more accurately reflect the pipeline scenario in the Assessment. As presented the Assessment, the conclusions on release impact are not supported because spill frequency statistics do not support a full bore release from a 20 cm, double walled, pipeline release condition.		Environmental consequences of pipeline failure	Conclusions are based on unrealistic or non representative assumptions.

Page	Section	Excerpt	Contributor	Technical Comment	Citations	General Subject Area	Comment Category
6 27	6.2.2.3	The percentage of water reintroduced to streams, including uncontrolled leachate escapes, would equal 74, 40, and 70% of the total water captured in the three scenarios, respectively. (underline added for emphasis)	ERM	In this paragraph and elsewhere, the Assessment refers to uncontrolled leachate and appears to assume the quantities are large. However, elsewhere it is assumed that groundwater interception wells and pump backs will extend the cone of depression. It appears this is leading to a "worst of both cases" scenario. The WRDs will be built in lifts that result in high compaction layers that minimize infiltration and are typically designed to direct internal drainage to a designated collection point. In other words, the collection system is inherently more robust than implied in the Assessment.		WRD and TSF Seepage	Inconsistent or mutually exclusive assumptions used in different places of the document, leading to multiple worst case scenarios that would not all reasonably occur.
6 27	6.2.2.4	Water treated at the wastewater treatment plant (WWTP) and discharged into streams might not be reintroduced into the same dewatered streams. The WWTP is assumed to discharge to the South and North Fork Koktuli Rivers, but not to Upper Talarik Creek (Figures 6 8 through 6 11).	ERM	The Assessment has assumed no release of treated water to Upper Talarik and that the releases to the SFK and NFK are point source and at one location in each catchment. This is counter to the general environmental design approaches for water management (and good practice) that diversions and replacement flows are best returned to the original catchments. This assumption results in a flawed assessment of flow impacts.		Water Management/ Treatment	Conclusions are based on unrealistic or non representative assumptions.
6 35	6.3.4	The well field placed downstream from the TSF during operations would be retained and monitored post closure, with water pumped and treated if determined to be contaminated by leachate from the TSF. The pit water would be monitored and treated prior to being released to streams, for as long as concentrations of contaminants exceeded effluent limits.	ERM	Assumes capture of leachate so should be no/minimal release to wider environment. However, elsewhere the Assessment assumes leachate escapes and contaminates the streams.		Water Management/ Treatment	Inconsistent or mutually exclusive assumptions used in different places of the document, leading to multiple worst case scenarios that would not all reasonably occur.
7 3	Conceptual Model	Conceptual Site Model - Associates between Salmon populations and enviornmental stressors associated with mine footprint operations	ERM	The assessment is unclear on what spatial scale this CSM referrs to and how the mine footprint overlays on the various scales of possibility.	No reference provided	CSM for salmon populations	Spatial Scale of CSM
7 33	7.3 Streamflow Modification	Section describes indirect impacts from water withdrawls on stream flow conditions. It describes a >20% reduction in stream flow for the PLP 0.25 scenario will result in a 15 km of stream reach of reduced fish habitats.	ERM	The assessment's conclusions are based on modeling of scenarios that are not realistic and do not include mitigation measures.	Cites GW modeling reports	Fish and Fish Habitat effects of water reduction	Conclusions are based on unrealistic or non-representative assumptions.
7 45	7.3.1	It is important to note that the WWTP is designed to discharge to the South and North Fork Koktuli River watersheds via the WWTP outfalls, so no treated flow from the Upper Talarik Creek watershed would return to source streams in that watershed.	ERM	This is a simplistic approach to discharge management and does NOT represent best practice. It is good practice that discharges optimize release patterns to maximize the environmental value of the discharges (and to minimize negative effects of any discharge).		Streamflow Management/Mitigation	Conclusions are based on unrealistic or non-representative assumptions.
7 48	7.3.1.4	After the mine closes, pit dewatering would cease, leading to pit filling. As the pit fills, water from the pit that had been returned to streams via pumping to the WWTP would no longer be available for streamflow.	ERM	Assumes that pit dewatering would cease immediately after closure commences (ie mining operations cease). Good practice would be to slowly reduce pumping to provide a gradual transition from dewatering/ treatment/ discharge to minimize quality issues and also maintain streamflows.		Water Management/ Treatment	Conclusions are based on unrealistic or non representative assumptions.

Page	Section	Excerpt	Contributor	Technical Comment	Citations	General Subject Area	Comment Category
7 59	7.3.4	However, model results were very sensitive to the location of WWTP discharges. For example, in this assessment we estimated reductions in streamflow of 46% in Upper Talarik Creek at gage UT100D (Tables 7-19 and 7-20). Wobus et al. (2012) estimated much less severe reductions of less than 10%, largely, because their assessment placed one of the two WWTP outfall points at this location (Table 7-20) and ours did not. Other significant divergences between streamflow alteration estimates in this assessment and Wobus et al. (2012) also are most likely due to differences in the location of the WWTP outfalls (Table 7 20).	ERM	Assessment acknowledges that location of WWTP outfall is critical to impact assessment; however, it does not consider the very obvious design option of directing flows to multiple points and to the UT. The Assessment does acknowledge that different (and reasonable) assumptions significantly reduce impacts. Good practice is to model the outcomes of different locations and then optimize the locations and volumes to minimize the impacts.		Water Management/ Treatment	Conclusions are based on unrealistic or non-representative assumptions.
8 1	8.1	This failure represents one potential failure among many accidents and failures that could occur. We specify that under routine operations, the WWTP would meet permit limits; in the event of a complete treatment failure, flows would pass through the WWTP at the estimated influent concentrations. These two water collection, treatment, and discharge scenarios bound the likely degrees of water treatment failure, but do not encompass the worst case.	ERM	Assumes no buffer between plant and discharge and also appears to misunderstand the nature of sequential water treatment processes that would be employed for the water treatment (i.e., the treatment is a series of units to remove the various elements and copper is one of the easiest to remove). Thus the potential for a complete failure of all processing steps is not plausible unless there is a failure in water supply to the plant (i.e., no water to treat so no discharge possible). It also ignores that there would be multiple, parallel treatment trains. The assumptions also ignore that reverse osmosis is typically one of the last steps in the sequence and failure is not through 'breakthrough' where untreated water is released but is fouling of the membrane that prevents any water passing through. Furthermore, however unlikely and as noted elsewhere, per well established best practices untreated waste water would be pumped to the TSF or the pit and not discharged to the environment.		Water Management/ Treatment	Conclusions are based on unrealistic or non-representative assumptions.
8 19	8.1.2	To bound the range of reasonable possibilities, we assess a serious failure in which the WWTP allows untreated water to discharge directly to streams. This type of failure could result from a lack of storage or treatment capacity or treatment efficacy problems. We evaluate potential effects of this type of failure using the following assumptions.	ERM	The failure mode of direct release is neither sensible nor reasonable failure of the WWTP would typically (and under good management practices) be directed to the pit (or a TSF depending on topographical relief). Even if direct release occurred, the quantity would be significantly smaller, as the practice is to cease processing of water. The failure assumptions are too extreme, being worst case on worst case and also based on failure modes that are not a common basis of design for water treatment plants whether for mining or other industries.		Water Management/ Treatment	Conclusions are based on unrealistic or non-representative assumptions.
8 24	8.2.1.1 Effluent Dilutionn and Transport	PLP (2011) found that copper levels in some samples from the South Fork Koktuli River exceeded Alaska's chronic water quality standard. However, most of the exceedances were "in sampling locations within or in proximity to, the general deposit location" and the number and magnitude of exceedances decreased with distance downstream (PLP 2011: Figure 9.1 35). Therefore, the stream reaches with significantly elevated copper concentrations would be largely destroyed by the mine scenario footprints and by water diversions.	ERM	The Assessment documents that PLP found elevated copper cooncentrations in upper stream reaches. It further acknowledges that those headwaters are in locations under the mine footprint. What the Assessment does not explicitly acknowledge is that these are the very reaches about which concern is expressed. These reaches, with high value fish resources are by current accounts not apparently impacted by the (naturally) elevated copper concentrations.	PLP 2011 EBD	Baseline data representation	Information is presented out of context or in a misleading way.

Page	Section	Excerpt	Contributor	Technical Comment	Citations	General Subject Area	Comment Category
8 27	8.2.2.1 Copper	Table 8 11 shows results of benchmark derivation using the BLM approach	ERM	While the BLM approach is preferred over the old standard and the USEPA uses it in the derivation of standards in the Ambient Water Quality Criteria document, a more complete review of the BLM approach, assumptions, and input data is required for a thorough assessment.	USEPA 2007 Ambient Water Quality Criteria	Water Quality Criteria	Insufficient analysis or technical basis from which to draw the conclusions presented.
8 29	8.2.2.1 Copper, Alternative Endpoints	Although effects on fish olfaction have not been shown to affect the viability of field populations, it is reasonable to expect that interference with these essential processes would have population-level consequences (DeForest et al. 2011b).	ERM	Indirect and sub-lethal effects have not been conclusively shown to influence field populations. The statement that it is reasonable to assume that such a sub-lethal effect would have a wide ranging population-level effect is not substantiated by the majority of toxicology literature.	DeForest et al,. 2011 b	Water Quality Criteria	Insufficient analysis or technical basis from which to draw the conclusions presented.
9 1	9.1 Overview	A breach of a TSF 1 dam would result in a flood wave and subsequent tailings deposition that would greatly alter the downstream channel and floodplain.	ERM	This kind of introduction to the failure scenarios should be introduced with a contextual statement related to the (very low) probability of a catastrophic event such as the one described. The way it is written, it does not provide that context.		TSF Failures	Information is presented out of context or in a misleading way.
9 36	9.5.2.1 Exposure	The composition of the aqueous phase is uncertain. None of the tests performed by PLP represents the leaching conditions in a tailings impoundment, and no model exists to mathematically simulate the leaching process.	ERM	As the Assessment does not have any evidence of concentration of impoundment water concentrations, the authors were left to speculate on a concentration. Conclusions need to be read in that context. No discussion on the level of certainty of speculated concentrations is used and the reader is left without a complete (or correct) context.		Impoundment aqueous phase concentrations	Information is presented out of context or in a misleading way.
9-46	9.5.2.3 Risk Characterization - Chronic Toxicity from Sediment Chemicals	Sediment quality guidelines provide another line of evidence to assess risks from tailings after a tailings dam failure. Table 9-9 shows that tailings would be expected to cause severe toxic effects on the organisms that live in or on them. Notably, copper concentration would be 4.5 times the PEC; chromium and nickel concentrations would also exceed their PECs. The sum of TEC quotients of 32 implies that tailings would need to be diluted by 32 parts clean sediment to one part tailings before toxic effects would be unlikely (below the TEC). Because the Bristol Bay watershed is relatively undisturbed, background levels of total suspended solids are low (Table 8 10), so the time required to achieve that degree of dilution would be very long.	ERM	This section overstates the conclusions. Typical sediment investigatons relying on comparison to benchmarks such as TELs/PELs that find exceedances show that there is only a probability of impact. Further studies would be necessary to understand the exact site-specific nature of the predicted threshold effects. This is the typical approach in an ecological risk assessment.	McDonald 2000	Sediment Quality Criteria	Insufficient analysis or technical basis from which to draw the conclusions presented.
10.31	10.3.3.2	A risk assessment by Environment Australia estimated that a spill of as little as 10% of a 25-metric-ton-capacity truck of sodium ethyl xanthate into a stream would require a "650000:1 dilution before the potential hazard is considered acceptable" and that the spill could not be mitigated (NICNAS 2000).	ERM	The scenario assumes that the entire capacity is in one container and therefore all could spill. In practice, reagents such as sodium ethyl xanthate are transported in smaller containers that frequently have additional lining/protection in each container. In addition, it is common practice in sensitive areas to transport reagents inside sealed shipping containers to further reduce the risk of damage to individual reagent containers. So the likelihood of 10% of the entire volume being released is very small.		Transport Corridor/transport of reagents.	Conclusions are based on unrealistic or non representative assumptions.

Page	Section	Excerpt	Contributor	Technical Comment	Citations	General Subject Area	Comment Category
10-35	10.3.5.1 Exposure	Page 10-35: The amount of dust derived from a road surface is a function of many variables, including composition and moisture state of the surface, amount and type of vehicle traffic, and speed. An Iowa Highway Research Board project (Hoover et al. 1973) that quantified dust sources and emissions created by traffic on unpaved roads found that one vehicle, traveling 1 mile of unpaved road once a day every day for 1 year, would result in the deposition of 1 ton of dust within a 1,000-foot corridor centered on the road (i.e., traffic would annually deposit 1 ton of dust per mile per vehicle). Page 10-36: Based on the estimate from Hoover et al. (1973), the average amount of dust (in tons) generated per mile of road per year along the transportation corridor within the Kvichak River watershed would be equivalent to the daily average number of vehicles passing along the corridor (one vehicle making a round-trip constituting two passings). Using this method, the mine scenarios would generate approximately 105 tons of dust per mile (59 metric tons per km) annually or approximately 6,700 metric tons annually for the entire length of road within the Kvichak River watershed. This value may be underestimated because smaller vehicles use typical rural roads in Iowa, or overestimated if roads in Iowa are dryer or if dust suppression is effective, but it indicates that dust production along the transportation corridor could be substantial.	ERM	The exposure characterization does not account for the lower driving speed for large trucks anticipated in the Alaska rural road context compared to smaller vehicles in the Iowa rural road context of Hoover et al. 1973. As such, the value may be an overestimate because driving speed along rural roads in Iowa is likely higher than for large trucks along rural roads in Alaska. In addition, the assessment assumes that dust suppression is not effective which is an inaccurate assumption given that dust suppression is a critical industry best practice and permit condition of any mine. Furthermore, operation of the transportation corridor would need to meet air quality standards, including for dust. Overall, the assessment does not account for or adjust for baseline sources of fugitive dust emissions (pre mine context) in the area. According to an ADEC Rural Dust Survey (2010) of rural Alaskan communities, including Kokhanok, Nondalton, and Pedro Bay, there are existing problems with road dust, in particular from speeding ATV traffic on gravel or dirt roads.	Alaska Department of Environmental Conservation (ADEC). Air Quality Division. ADEC Rural Dust Survey Preliminary 2010 Results.	Transportation/Culverts/ Crossings	Conclusions are based on unrealistic or non-representative assumptions.
10-41	10.5 Uncertainties	Estimation of dust production from the transportation corridor. Our dust production estimate is based on a study that quantified dust sources and emissions created by traffic on unpaved roads. Extrapolating that study to the transportation corridor does not take into account variables such as composition and moisture of the road surface, number of tires and their widths, and speed. In addition, road dust generation may be reduced by 50 to 70% by the application of dust control agents such as calcium chloride. Overall, these uncertainties likely have a negligible effect on risks to fish, but a moderate effect on our dust production calculations.	ERM	The exposure characterization does not account for the lower driving speed for large trucks anticipated in the Alaska rural road context compared to smaller vehicles in the Iowa rural road context of Hoover et al. 1973. As such, the value may be an overestimate because driving speed along rural roads in Iowa is likely higher than for large trucks along rural roads in Alaska. In addition, the assessment assumes that dust suppression is not effective which is an inaccurate assumption given that dust suppression is a critical industry best practice and permit condition of any mine. Furthermore, operation of the transportation corridor would need to meet air quality standards, including for dust. Overall, the assessment does not account for or adjust for baseline sources of fugitive dust emissions (pre mine context) in the area. According to an ADEC Rural Dust Survey (2010) of rural Alaskan communities, including Kokhanok, Nondalton, and Pedro Bay, there are existing problems with road dust, in particular from speeding ATV traffic on gravel or dirt roads.	Alaska Department of Environmental Conservation (ADEC). Air Quality Division. ADEC Rural Dust Survey Preliminary 2010 Results.	Transportation/Culverts/ Crossings	Conclusions are based on unrealistic or non-representative assumptions.

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11-5 and 11-6	11.1	Although the range of published annual failure rates for oil and gas pipelines spans more than 1 order of magnitude (0.000046 to 0.0011 per km) (URS 2000), the range for pipelines most similar to the assessment pipelines along the transportation corridor is much narrower. For example, the failure rate is 0.0010 failure/km ·yr for pipelines less than 20 cm in diameter (OGP 2010), 0.0015 failure/km ·yr for pipelines in a climate similar to Alaska (Alberta, Canada) (ERCB 2013), and 0.00062 failure/km ·yr for pipelines run by small operators (those operating total pipeline lengths less than 670 km) (URS 2000). The geometric mean of these three values yields a probability of failure of 0.0010 failure/km ·yr.	ERM	The frequency data used in the cited references were developed using PHMSA's and EUB pipeline incident dataset. An entire dataset includes releases from discrete and mainline elements, both of which have different release frequencies. The applicability of using a release frequency based upon an entire dataset rather than a scenario-specific frequency should be discussed.		Environmental consequences of pipeline failure	Conclusions are based on unrealistic or non-representative assumptions.
11-5 and 11-6	11.1	Complete break or equivalent failure of the product concentrate pipeline. Complete break or equivalent failure of the return water pipeline. Complete break or equivalent failure of the diesel pipeline.	ERM	The frequency data used in the cited references were developed using PHMSA's and EUB pipeline incident dataset. The entire dataset includes releases from all reported spill volumes ranging from leaks to ruptures. Use of frequency data for all incidences rather than for a full bore rupture as described in the scenario overestimates the likelihood of a spill related to a full bore rupture.		Environmental consequences of pipeline failure	Conclusions are based on unrealistic or non-representative assumptions.
11-6	11.1	It may be argued that engineering can reduce pipeline failures rates below historical levels, but improved engineering has little effect on the rate of human errors.	ERM	The Assessment includes a cursory discussion of the causes for a pipeline release but should identify the applicable causes for the scenario pipelines. The release frequencies of these causes should then be used in developing the applicable scenario release frequency. The Assessment states that improved engineering has little effect on the rate of human error release frequency but this has not been demonstrated. The text should establish what the release frequency is for human error and its materiality on the frequency rates used.		Environmental consequences of pipeline failure	Information is presented out of context or in a misleading way.
11-7	11.2	Total travel times to Iliamna Lake are estimated to be 240 minutes and 24 minutes for a Chinkelyes Creek and a Knutson Creek spill, respectively.	ERM	The estimated transport time represents the time the slurry is predicted to first arrive at the water body and not the time for the entire slurry to empty into the water body. The report should address the total time for the mass to reach the receptor and the rate of introduction.		Environmental consequences of pipeline failure	Insufficient analysis or technical basis from which to draw the conclusions presented.
11-7	11.2	Total travel times to Iliamna Lake are estimated to be 240 minutes and 24 minutes for a Chinkelyes Creek and a Knutson Creek spill, respectively.	ERM	The evaluation is a very simplistic approach to assessing the fate and transport of a release from a pipeline. The estimated transport time represents the estimated time for the slurry to first arrive at the water body and not the time for the entire slurry mass to empty into the water body. The time to drain down the pipeline is not addressed and because it is absent the reader assumes that all the mass is released at once rather than over time. The report should address the total time for the mass to reach the receptor and the rate of introduction.		Environmental consequences of pipeline failure	Insufficient analysis or technical basis from which to draw the conclusions presented.
11-8	11.2	Flows were calculated from precipitation models used to determine mean annual runoff for the assessment's stream culvert analysis	ERM	The evaluation is not sufficiently transparent to assess if the slurry characteristic and channel surface roughness are taken into account to calculate the flow rates and transit time to the defined receptors. Because the information is not readily discernable from the text and tables, it is unclear if appropriate hydrologic flow conditions are used in the preciptation model and the accuracy cannot be reasonably and critically reviewed. The precipitation model should be identified and the condition for overland and channel flow should be defined.		Environmental consequences of pipeline failure	Information is presented out of context or in a misleading way.

Page	Section	Excerpt	Contributor	Technical Comment	Citations	General Subject Area	Comment Category
11 8	11.3.1	During the entire spill, gravity drainage governs the flow rate based on calculations for free-flowing pipes.	ERM	The evaluation is not sufficiently transparent to assess the length of the pipeline subject to draindown, the slope of the pipeline, the effect of slurry characteristics on flow through a hole, and how draindown time and volume were estimated. Without this information, the analysis would be incomplete. The approach and assumptions used in this evaluation result in a slurry release rate and volume to the environment. Therefore, if the approach and assumptions are inaccurate, the release rate and volume are inaccurate, and as a result, the conclusion regarding the mass reaching a receptor and the total time for the entire release volume to reach the receptor are inaccurate.		Environmental consequences of pipeline failure	Information is presented out of context or in a misleading way.
11.8	11.3.1	The estimated total slurry volume draining to the stream would equal the pumped flow rate times 5 minutes, plus the volume between the break and local high point in the pipeline.	ERM	The evaluation is not sufficiently transparent to assess what pumped flow rate was used for the scenario pipelines, what pipeline draindown lengths, rate, and time were used, and whether the flow rates are based on the physical characteristics of water or the slurry mix. Because the information is not readily discernable in the text and tables, the accuracy of the mass release estimates and the eventual effect cannot be reasonably and critically reviewed.		Environmental consequences of pipeline failure	Information is presented out of context or in a misleading way.
11 9	11.3.2	Under these concentrate pipeline failure scenarios, 67 metric tons of product concentrate would be released into Chinkelyes Creek or 24 metric tons into Knutson Creek.	ERM	The evaluation is not sufficiently transparent to assess what pumped flow rate was used for the scenario pipelines, what pipeline draindown lengths, rate, and time were used, and whether the flow rates are based on the physical characteristics of water or the slurry mix. Because the information is not readily discernable in the text and tables, the accuracy of the mass release estimates and the eventual effect cannot be reasonably and critically reviewed.		Environmental consequences of pipeline failure	Information is presented out of context or in a misleading way.
11-10	11.3.2	In other words, we expect 1 to maybe 2 such spills in the Pebble 6.5 scenario. Similarly, a spill would have a 35% probability of entering a wetland, resulting in an estimate of 0.038 wetland contaminating spills per year or 2 wetland contaminating spills in the Pebble 6.5 scenario.	ERM	The frequency data used in the cited references were developed using PHMSA's and EUB pipeline incident dataset. An entire dataset includes releases from discrete and mainline elements, both of which have different release frequencies. The applicability of using a release frequency based upon an entire dataset rather than a scenario-specific frequency should be discussed. Because of the inclusion of leaks with rupture frequencies in the evaluation, the conclusion that a spill would enter a wetland is an over estimation of the probabiliy of occurence.		Environmental consequences of pipeline failure	Conclusions are based on unrealistic or non representative assumptions.
11-10	11.3.5	For example, TransCanada's risk assessment for the Keystone XL pipeline assumed that the time to detection would range from 90 days for a small leak (1.5% of pumping volume) to 9 minutes for a large leak (50% of pumping volume) and that an additional 2.5 minutes would be required for the shutdown sequence (DNV Consulting 2006, O'Brien's Response Management 2009). Therefore, a large spill like the one assessed here would leak for 11.5 minutes based on a state of practice design from an experienced company. This is more than twice our assumed duration.	ERM	The flow dynamics of shutting down a 36 inch diameter line transporting between 700,000 and 800,000 barrels of crude oil per day (Keystone XL) are not the same as shutting down a 20 cm diameter line. Shutdown of large diameter and high flow pipelines must be done in a way as to not cause a breach in the pipeline elsewhere. The example used is a not relevant comparison for shutdown time and the assumed 5 minute shutdown time should be supported by pipeline systems of similar construction and flow.		Environmental consequences of pipeline failure	Insufficient analysis or technical basis from which to draw the conclusions presented.

Page	Section	Excerpt	Contributor	Technical Comment	Citations	General Subject Area	Comment Category
12-6	Report Section Effects on Alaska Natives: 12.2	A shift from part time to full time wage employment in mining or mine-associated jobs would affect subsistence-gathering capabilities by reducing the time available to harvest and process subsistence resources.	ERM	While it is reasonably possible, as the Assessment states, that this may reduce the time available to harvest and process subsistence resources, the Assessment fails to also state that it may also increase the time available. For example, those employed or contracted could have more time for subsistence use harvesting as a result of favorable rotational periods; also, more income could also enable harvesters to purchase better equipment (e.g., faster snow machines, bigger boats, better rifles) enable them to be more time efficient.		Subsistence Use	Information is presented out of context or in a misleading way.
12.6	Report Section Effects on Alaska Natives: 12.2	Social networks are highly dependent on procuring and sharing salmon and wild food resources, so the current social support system would be significantly degraded.	ERM	The Assessment makes subjective statements in this regard, without presenting sufficient evidence that changes to social networks in the area due to mining will be "significant".		Cultural	Insufficient analysis or technical basis from which to draw the conclusions presented.
12-6	12.2 Effects on Alaska Natives	A shift from part time to full time wage employment in mining or mine-associated jobs would affect subsistence-gathering capabilities by reducing the time available to harvest and process subsistence resources.	ERM	This statement is an inaccurate assumption and does not take into account mitigation measures such as subsistence leave policies for local employed residents, which is an industry best practice to provide flexible work schedules to accommodate subsistence harvest periods. Furthermore, the statement provides an incomplete picture on the potential effects of employment on subsistence activity. Subsistence activity these days has become modernized to require costly inputs (e.g., ammunition, boats, snow machines, etc.). A study of Alaska's North Slope Iñupiat people found that while there can be an inverse relationship between active subsistence harvesting and wage labor time for the individual worker, cash from employment is often used for subsistence inputs (i.e., gasoline, boats, ammunition)(Kerkvliet, JNW, 1997). Thus, employment can positively support a community's overall subsistence-gathering capabilities, as well as harvest-sharing capabilities.	Kerkvliet JNW. Whaling and wages on Alaska's north slope: a time allocation approach to natural resource use. Economic Development and Cultural Change. 1997;45:651.	Subsistence Use	Conclusions are based on unrealistic or non-representative assumptions.

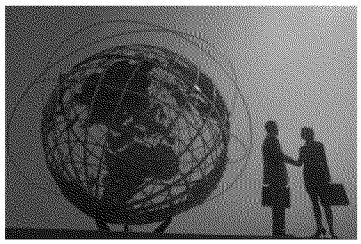
Page	Section	Excerpt	Contributor	Technical Comment	Citations	General Subject Area	Comment Category
12-9	12.2.1 Subsistence Use	On a physical level, the loss of salmon as a highly nutritious wild food, and the substitution of purchased foods, would have a negative effect on individual and public health (Appendix D). Salmon is especially valued around the world for nutrition and disease prevention. Dietary transition away from subsistence foods in rural Alaska carries a high risk of excess consumption of processed simple carbohydrates and saturated fats.	ERM	The assessment does not take into account the diverse traditional foods (including other non-salmon fish, caribou etc.) in the diet of the subsistence communities that can mediate (to a certain extent) the need to subsistute with purchased foods. Nor does the assessment account for the existing higher rates of consumption of processed market foods observed among rural Alaskans that influence the health of the community. For instance, rural Alaskans have been found to drink three times as much soda per day as their urban counterparts, and two-year-olds in northern and southwestern regions of the state are twice as likely to regularly consume sugar sweetened beverages as two year olds statewide (Fenaughty A., 2009; CDC, 2010). High consumption of these beverages is associated with a number of health problems such as obesity, diabetes, and cardiovascular disease.	Fenaughty A, Fink K, Peck D, Wells R, Utermohle C, Peterson E. The Burden of Overweight and Obesity in Alaska, Summary Report. December 2009. Anchorage, AK: Section of Chronic Disease Prevention and Health Promotion, Division of Public Health, Alaska Department of Health and Social Services. CDC Guide to Strategies for Reducing the Consumption of Sugar Sweetened Beverages. Centers for Disease Control and Prevention. March, 2010. Accessed online at http://inhealthyweight.org/files/StratstoReduce_Sugar_Sweetened_Bevs.pdf	Subsistence Use	Insufficient analysis or technical basis from which to draw the conclusions presented.
12-9	12.2.1 Subsistence Use	A study of the cumulative environmental effects of oil and gas activities on Alaska's North Slope reports that subsistence hunting areas have been reduced, the behavior and migratory patterns of key subsistence species have changed, and that there is increased incidence of cancer and diabetes and disruption of traditional social systems (NRC 2003).	ERM	The discussion does not accurately represent the findings in the NRC 2003 report, suggesting that there is an actual link between oil and gas activities and the increased incidence of cancer and diabetes. The NRC 2003 study did not base the effect of increased incidence of cancer and diabetes on epidemiological evidence; but rather, on reports by North Slope residents, as indicated in the following excerpt from the NRC 2003 report: *"North Slope residents also reported that traditional subsistence hunting areas have been reduced, the behavior and migratory patterns of key subsistence species have changed, and that there is increased incidence of cancer and diabetes and disruption of traditional social systems."*		Alaska Native Culture	Information is presented out of context or in a misleading way.

Page	Section	Excerpt	Contributor	Technical Comment	Citations	General Subject Area	Comment Category
12-10	12.2.2 Perception of Food Security	Aside from actual exposure to environmental contamination, the perception of exposure to contamination is also linked to known health consequences, including stress and anxiety about the safety of subsistence foods and avoidance of subsistence food sources (CEAA 2010, Joyce 2008, Loring et al. 2010), with potential changes in nutrition-related diseases as a result.	ERM	The Assessment asserts a pathway of effect that does not take into account existing modifiable risk factors for nutrition-related diseases (such as alcohol use, smoking, lack of access to fresh vegetables, consumption of sugary beverages, etc.) that influence the health of the community. Without accounting for these co-founding factors, the Assessment is inaccurate in asserting a high certainty for anticipating changes in human health, specifically physical health, during the Mine Project scenario. Overall, Chapter 12 lacks a discussion on baseline conditions (i.e., pre mine context) as a reference point for determining potential changes in human health at the community level. For instance, published public health data indicate that the Bristol Bay Region currently have high burdens of nutrition-related health problems (e.g., obesity and diabetes) and chronic diseases (e.g., heart disease and cancer) (UW's County Health Rankings, 2012; ANTHC, 2008).	University of Wisconsin's County Health Rankings, 2012. Profiles for Lake and Peninsula Borough and Dillingham Census Area. ANTHC, 2008. Regional Health Profile: Bristol Bay Health Corporation. Alaska Native Epidemiology Center, Alaska Native Tribal Health Consortium.	Alaska Native Culture	Insufficient analysis or technical basis from which to draw the conclusions presented.
12-11	Report Section Effects on Alaska Natives: 12.2		ERM	Box 12.1, dead link at www.epa.gov/bristolbay		Subsistence use	Link not working
12-11	Report Section Effects on Alaska Natives: 12.2	Some residents have expressed a desire for jobs and development related to large scale mining and a market economy, whereas other residents have expressed concerns that this type of economic shift would be detrimental to their culture (Box 12-1, Appendix D).	ERM	The only comments provided in Box 12-1 are concerns about culture, but nothing about "desire for jobs and development" as indicated in this excerpt.		Socio-economic	Conflicting or Inconsistent Information
12-12	Report Section Effects on Alaska Natives: 12.2	However, increases in personal income may not be the best measure of benefits, and should be considered over the long term, as oil and gas resources are exhausted and future opportunities—	ERM	Comment speaks about "oil and gas resources", but the start of the paragraph and other paragraphs above this refer to large-scale mining development, not O&G development. Should also point out for greater balance that the mine upon which the Assessment is based would likely have decades of operational potential, not just a few years, as may be more typical of the O&G sector.		Socio-economic	Information is presented out of context or in a misleading way.
12-14	12.2.4 Social, Cultural, and Spiritual Impacts	According to NRC (2003), increased alcoholism, drug abuse, and child abuse have resulted from the stresses inherent in integrating traditional and new ways of life. Health effects also are apparent, as the incidence of diabetes has increased with higher consumption of non subsistence foods (NRC 2003).	ERM	Section overall does not provide a balanced view of findings from the NRC 2003 report. The following excerpt from the NRC 2003's Report in Brief indicates that the North Slope residents also recognized the positive health impacts associated with oil and gas activities: "*Most North Slope residents have positive views of many of the economic changes that have resulted from revenue generated by petroleum activities, such as access to better medical care, availability of gas heat for houses, improved plumbing, and higher personal incomes.*"	NRC, 2003. *Report in Brief: Cumulative Environmental Effects of Oil and Gas Activities on Alaska's North Slope.* Washington, DC: The National Academies Press.	Alaska Native Culture	Information is presented out of context or in a misleading way.

Page	Section	Excerpt	Contributor	Technical Comment	Citations	General Subject Area	Comment Category
12-17	12.3 Uncertainties	The magnitude of effects on Alaska Native cultures resulting from any mining-associated changes in salmon resources is unknown, but other studies related to resource extraction industries (North Slope, Red Dog Mine) or environmental contamination (Exxon Valdez) in Alaska confirm that there certainly would be changes in human health and Alaska Native cultures.	ERM	The assertion of a high certainty for anticipating changes in human health, specifically physical health, is not supported by the studies referenced in this section (North Slope and Red Dog). These studies do not provide epidemiological evidence that supports an association between the resource extraction activity and physical health outcomes (e.g., diabetes, cancer, etc.). But rather, for the Red Dog study, quantitative risk assessment indicated no health risks as mentioned in the statement from this section: *"These concerns persist even though studies by the Alaska Department of Health and Social Services found that heavy metal concentrations in drinking water were low and did not pose a risk (USEPA 2009)."* In addition, ADHSS (2001) conducted a site specific human health risk assessment on the Red Dog Mine that estimated the risk from exposure to metals through subsistence food consumption and concluded that the risk was within acceptable limits. Overall, Chapter 12 lacks a discussion on baseline conditions (i.e., pre mine Project context), including existing modifiable risk factors for diseases, as a reference point for determining potential changes in human health at the community level. Without accounting for these co founding factors, the assessment is inaccurate in asserting a high certainty for anticipating changes in human health, specifically physical health, during the Mine Project scenario.	ADHSS. 2001. Public Health Evaluation of Exposure of Kivalina and Noatak Residents to Heavy Metals from Red Dog Mine. October 25, 2001, Environmental Public Health Program Section of Epidemiology, Alaska Division of Public Health.	Alaska Native Culture	Insufficient analysis or technical basis from which to draw the conclusions presented.
13-7	Cumulative Impacts	The ADF&G management strategy, based on maximum sustainable yield, is considered a success in maintaining sustainable salmon harvests (Hilborn et al. 2003, Hilborn 2006).	ERM	The assessment relies on ADF&G assessments on yeild to establish sustainable levels. These data are obtained from observer reports of escapment. It is unclear in the Assessment what defines sustainable harvests. Furthermore, it is not clear what level of industrial fishing is necessary to influence the sustainability of salmon stocks.	ADF&G data, Hilborn et al. 2003, Hilborn 2006.	Sustainable fisheries	Definition of sustainable in this context.
20-21	Appendix E Section Summary of Economic Significance		ERM	Table 5 Cash Economy Full-time Equivalent Employment Count by Place of Work in the Bristol Bay Region, 2009. Table 6. Cash Economy Estimated Economic Significance of Bristol Bay Ecosystems. These provide a single snapshot, and do not indicate how employment has changed over time.		Socio economic	Information is presented out of context or in a misleading way.
D-3	Report Section Appendix D: Executive Summary	Since the social networks are highly dependent on procuring salmon (fish camps) but also sharing salmon and wild food resources, the current social support system would be appreciably degraded.	ERM	In this section, "appreciably degraded" is used, not "signficantly degraded". This is an important point to consider since "significance" indicates scientific rigour in the analysis was used.		Cultural	Information is presented out of context or in a misleading way.

Tania Barron

ERM Global Lead for Health
ESHIA to Equator Principles/IFC Standards Expert



Ms. Tania Barron is ERM's global lead for the Health Impact Assessment sub-practice, based in Seattle, Washington. Her expertise lies in leading and conducting health and social impact assessments, stakeholder engagement and providing strategic advice and training following international standards (EP / IFC) to private sector clients to help them manage the health/ social and sustainability risks of their operations. Tania has experience working in a variety sectors including in oil and gas, mining, manufacturing and agriculture as well as with international development banks such as the World Bank, the IFC and the IDB.

Ms. Barron has worked on a variety of projects across global regions, including health impact assessments (HIAs) for a Hydrocarbon Production EIS natural gas drilling project in Alaska, for Chevron in the Piceance Basin, Co; for an oil refinery project for Sonangol in Angola; for a bauxite refinery project in Guinea and a smelter project in Greenland for Alcoa. Other relevant projects include an ESIA in Trinidad, a cumulative impact assessment for Hunt Oil in Peru, a social impact assessment for a facilities expansion for CerrejonCoal in Colombia, and a health issues screening assessment for Suralco in Suriname.

Prior to joining ERM, Ms. Barron worked on public health projects in both Latin America and the U.S. Ms. Barron previously served as a consultant for The World Bank in Washington DC, designing tools and processes to gauge and increase civil society and NGO stakeholder input into the design and implementation of World Bank projects.

Professional Affiliations & Registrations

- Global Health Nexus
- International Association for Impact Assessment

Fields of Competence

- Health Impact Assessments (HIA)
- Social Impact Assessment
- EP / IFC Training and ESHIAs following these standards
- Stakeholder Engagement and Public Consultation
- Health Promotion Programs / Social Investment
- Development of Sustainability and Project Risk Reduction Strategies
- Development of Performance Indicators
- Experience working with NGOs, civil society organizations, donors, and international financial institutions

Education

- Master's Degree in Public Policy, Harvard University, John F. Kennedy School of Government, 2005
- B.S. Social Psychology; course work in Public Health, University of Washington, 2000

Languages

- English (native)
- Spanish (native)

Key Industry Sectors

- Mining
- Oil & Gas
- Agriculture
- IFIs / International Organizations

Honors & Awards

- J. William Fulbright Scholarship Recipient, 2000-2001

Publications

- Community Health and Safety: Recommendations and Tools. Inter-American Development Bank (IDB) Technical Publication. Tania Barron 2011.
- Led a Business Roundtable on HIA in Alaska. Anchorage, Alaska. June 2010.
- Health Effects Assessment Tool (HEAT): An Innovative Guide to HIA in Resource Development Projects. Tania Barron & Marla Orenstein. 2009.

Key Projects

Health Impact Assessment as part of ESHIA

Social/Health Baseline Study, Stakeholder Engagement and Social Investment, Chevron, Gulf of Mexico, 2012 – 2013.
Led health component of study that included a baseline across 5 parishes. This allowed for a regional assessment and identification of social/ health sensitivites, issues and recommendations.

Social and Health Impact Assessment, Shell, Eagelford, TX, 2012 - 2013.
Led health component of the social and health impact assessment. Study included an analysis of public health issues and vulnerabilities in border region. Impact analysis and recommended mitigations and next steps were provided to client.

HIA Screening/Scoping for two Offshore Exploration Programs, Shell, Alaska 2012 - 2013.
Conducted two HIA screening/ Scoping processes for two different exploration programs for shell. Assessment provided recommendations on key health issues of importance, data gaps, recommendations on control measures and next steps.

Integrated ESHIA for Offshore Oil and Gas Project, Chevron, Angola, 2011.
Conducted a high-level assessment of health effects from a proposed offshore oil and gas project on a subsistence fishermen community. Assessment involved review of secondary health data and artisanal fishing survey.

HIA Screening/Scoping Process, Confidential Mining Client, Alaska 2012 - 2013.
Led a screening/ scoping process for an HIA for a mining and associated facilities project in Alaska, designed in alignment with the Technical Guidance for HIA in Alaska Toolkit and IFC Performance Standards.

Alumina Refinery Project HIA, Alcoa/Rio Tinto Alcan, Guinea West Africa Phase II, 2011 - 2013.
Responsible for leading the design and implementation of a health impact assessment as part of an ESHIA assessment. The HIA included an assessment of the potential impacts on the spread of disease, health services and infrastructure, traditional medicinal practices, traffic and accidents, emissions and noise among fence line communities. Recommendations on strategic health investments were also provided to the client.

Alumina Refinery Project Health Baseline, Alcoa/Rio Tinto Alcan, Guinea West Africa Phase II, 2008 - 2009.
Responsible for leading the design and implementation of a comprehensive health baseline assessment. Included secondary baseline data gathering as well as interviews with various health stakeholders ranging from the Ministry of Health to regional health officials, to local communities and traditional healers.

Sonaref Refinery Project ESHIA, Sonangol, Angola, 2007 - 2008. Led a total of 6 socio-economic and health studies for an integrated ESHIA for an oil refinery project in Lobito, Angola. Led a field team of 10 consultants for baseline observation and data collection. Developed an interim impact assessment report for the early works component of the project and developed assessment of health impacts and management plans for final report in 2008.

Health Impact Assessment for Braskem's Etileno XXL Project, Veracruz, Mexico, 2011 - 2013.
At the request of lenders, ERM was asked to develop a health impact assessment for a polyethilene plant in the state of Veracruz, Mexico. The HIA included in-depth baseline, impact assessment, management plans and recommendations on opportunities for strategic investment on initiatives to promote/ protect public health.

HIA as part of the ESIA for Suralco Nassau Bauxite Mine Project, Alcoa/Suralco, Suriname 2010 – 2011.
Completed a HIA for a mine site and road corridor project which involved developing health baseline studies, evaluating the health impacts and identifying mitigations and recommendations. In addition, an interim community health management plan was prepared to address the key community health risks and issues.

Integrated HIA for a Hydrocarbon Production EIS, Alaska, 2010 - 2011.
ERM was commissioned to integrate an Alaska-state led HIA into the project's EIS as part of the NEPA Review process. Developed health data gap analysis, reviewed cross-cutting issues in EIS relevant to health, liaised with state-led HIA team, and integrated the stand alone HIA into the EIS.

Smelter Project HIA, Greenland, Alcoa, 2008 – 2010.
Responsible for leading the design and implementation of a Health Impact Assessment for a smelter project including port, road and dam facilities, as part of an integrated ESHIA.

Guidance Document on the Health Effects Associated with Resource Development Projects, HIA Gateway, 2009.
Developed a guidance tool describing the types of health effects commonly associated with resource development projects. Guidance enabled companies and HIA practitioners to anticipate the range of public health effects associated with their projects.

Piceance Basin Natural Gas Development Program HIA, Chevron, Colorado, USA, 2007 - 2008.
Responsible for leading a Health Impact Assessment (HIA) to determine potential public health impacts to local communities associated to the proposed natural gas project, as part of a broader ESHIA.

Health Impact Assessment (HIA) Guidelines, Alcoa, 2007.
Responsible for developing corporate guidelines for the design, management and implementation of Health Impact Assessments for existing and new infrastructure projects.

Global Comparative Analysis of National Health Impact Assessment Regulation, Dow Chemical 2009 – 2010.
Conducted a benchmarki ng exercise of HIA regulations/ standards across global regions including USA; Canada; Thailand; China and various European countries. Made specific recommendations to the client on ways to prepare and manage risk.

Health Impact Assessment and Pilot Program to Reduce Pesticide Exposure, CIMAS Foundation, Ecuador, 2000 - 2001.
Project manager for the design and implementation of a program to reduce pesticide exposure among agricultural communities. Project consisted of developing a health impact assessment of pesticide use in flower plantations and on personal farming plots. The second phase of the project included the implementation of a health education program to increase awareness and reduce communities' exposure to pesticides.

Socioeconomic and Health Impact Assessment of the Cut-Flower Industry on Indigenous Communities, Fundacion CIMAS, Cayambe, Ecuador, 1999.
Conducted field research (i.e., design and implementation of household surveys, interviews, focus groups, anthropometric measurements) and desk-based research to assess the socioeconomic and health related impacts on local communities from the transition of subsistence farming to employment in the floriculture industry.

Community -Driven Health Promotion Program, Fred Hutchinson Cancer Research Center, Yakima Valley, WA, 2000 - 1999.
Designed community -driven health education programs for agricultural communities. Conducted capacity building workshops, developed materials and provided support for the implementation of pesticide health interventions, cancer prevention screenings and smoking cessations programs.

ESHIA Training and Capacity Building

IFC/Equator Principle Training, Teck, Vancouver, BC & Santiago Chile, 2011.
Delivered participatory IFC/ Equator Principles training in English and Spanish to Corporate and Business Unit managers including those in the following functional areas: EHS, legal, sustainability, finance, engineering etc. Presented and discussed latest revisions to the IFC Performance Standards, effective January 2012.

IFC Performance Standard Training, OPIC, Washington, DC. 2010.
Co-developed and delivered a tailored IFC Performance Standard training for executive and environmental staff at OPIC. Responsible for developing and delivering content related to social issues – including EIAs, management systems, stakeholder engagement, labor and human rights issues, community health, and indigenous people's issues etc.

IFC/Equator Principle Training, Barrick, Toronto Canada & Santiago, Chile, 2009.
Delivered IFC/ Equator Principles training in English and Spanish to Corporate and Business Unit managers including those working in the areas of EHS, sustainability , finance, engineering etc.

Community Health Case Studies and Training for IDB Staff, Washington, DC. 2010 – 2011.
Helped the IDB integrate community health into their existing social and environmental review process. Project involved assessing how health issues are addressed at three existing IDB financed projects and developing tolls and a training program for IDB staff.

Development of an HIA Guidance Note, Inter-American Development Bank (IDB), 2009 - 2011.
Tasked with developing a guidance note to help the IDB ensure that community health and safety risks and impacts are being addressed systematically and in alignment with international standards. Operational tools were developed to implement the HIA guidance.

Development of Indicators and Guidelines to Measure the Environmental Management Performance of Executing Agencies in Latin America and the Caribbean, IDB, 2006.
Developed a framework and a set of indicators to assess the environmental management capacity of private, public and financial intermediary borrowers to comply with in-country systems and with the IDB's new Environmental Safeguards Compliance Policy. Designed an electronic tool and scoring system to conduct assessments and to provide recommendations on ways to improve environmental management capacity of potential IDB borrowers.

Social Impact Assessment / Stakeholder Engagement

Stakeholder Engagement Strategy (SE) and Plan, Confidential Client, Alaska, 2012 - 2103.
Worked with client to assess existing SE efforts and to develop a more consistent approach to SE work including revision of SE mapping, action plan and tools and processes to support stakeholder engagement systems at the Project level.

SMART Exploration Training, Teck, Lima and Santiago, 2011.
Lead trainer for social risk management training for exploration teams in Lima and Chile. Training involved identifying social risk and working with teams to use tools to manage that risk across all the exploration stages.

Stakeholder Engagement Strategy and Action Plan Support, Pascua Lama Project, Barrick, Chile 2011 - 2012.
Provided training and capacity building support for community relations teams in order to help them improve their stakeholder engagement strategy and develop an engagement Action Plan aligned with IFC Standards.

Community Investment Strategy and Action Plan, Cerro Casale Project, Chile 2010 – 2011.
Led the development of a Community Investment Strategy and Action Plan for the Cerro Casale Project. The Strategy focused on creating a process for the Project to support community driven development projects/ programs that will yield sustainable benefits to communities in the area of influence of the project.

Jaguar Project ESIA, AEI, Guatemala, 2008 – 2009.
Responsible for leading and managing the social impact assessment (SIA) and the stakeholder engagement program for an ESIA of a power plant and transmission line project in the south coast of Guatemala. Led the social issues component of the presentation to lenders. Project accepted for IFC financing.

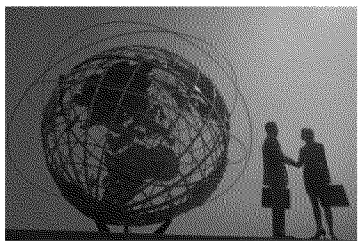
Community Relations Strategy and Performance Indicators, Barrick, USA, 2008.
Supported client in the development of a global community relations strategy, action plan and key performance indicators to track performance of the community relations function across global operations.

Pre-feasibility ESIA for Port and Railway expansion, Cerrejón Mine, Cerrejón Coal, Colombia, 2007.
Responsible for leading the social impact aspects of an alternatives analysis for a railway and port expansion. Identified new and cumulative impacts as well as management strategies for each alternative and recommended best option from a social standpoint.

Design and Implementation of an International Stakeholder Engagement Strategy for Cerrejón Mine, Cerrejón Coal, Colombia, 2006 – 2007.
Responsible for leading a US and Colombia based team in the development of a fit for purpose stakeholder engagement strategy to improve the relationship that Cerrejón Mine has with international stakeholders. The effectiveness of the strategy will be assessed through the development of indicators and an ongoing assessment of stakeholder perceptions/ relationship with Cerrejón Coal.

Cumulative Social Impact Assessment for Oil and Gas Developments in Blocks 56 and 88 in the Lower Urubamba Region, Hunt Oil, Peru, 2006.
Conducted a cumulative social and health impact assessment of existing and planned oil and gas development activities in the Lower Urubamba region. Project included desk-based research to identify expected social and health risks; an assessment of planned mitigation measures; a gap analysis; a significance risk-rating exercise; and recommendations.

David W. Blaha, AICP



Mr. David Blaha is a Partner with ERM based in Annapolis, Maryland. Mr. Blaha has 29 years of experience in environmental and social impact assessment, natural and cultural resource management, sustainable development, stakeholder consultation, and strategic advice for review or permitting of primarily large (>$US 1B) mining, infrastructure, and oil & gas projects.

Mr. Blaha is thoroughly familiar with both U.S. regulatory and procedural requirements (e.g., NEPA and CEQ guidance) and international EIA best practice (e.g., IFC Performance Standards, EBRD Performance Requirements, and Equator Principles). In addition to preparing Environmental and Social Impact Assessments, Management Plans, and Action Plans in accordance with international best practice, Mr. Blaha has worked with many Equator Banks, bilateral and multilateral financial institutions, and other lenders to conduct appropriate environmental and social due diligence, gap analysis, and construction/ operation compliance monitoring relative to the IFC Performance standards, Equator Principles, and other lender policy/ requirements.

He has extensive experience addressing biodiversity, indigenous peoples, wetlands, and water resource issues. Special expertise in evaluating mining and metals, power, land use, military, water resource, and transportation projects.

For mining, Mr. Blaha has significant experience in evaluating a wide range of groundwater and surface water issues associated with mining, including evaluating groundwater drawdown from pit dewatering (and potential indirect effects on wetlands), potential for acid rock drainage from waste rock dumps and tailings basins, overburden management, hydrometallurgical residue management, and impacts to downstream fisheries and aquatic habitat.

Professional Affiliations & Registrations

- American Institute of Certified Planners, 1986

Fields of Competence

- Sustainability planning including stakeholder engagement and development of sustainability indicators, metrics, and monitoring programs.
- Environmental and social impact assessment for a wide variety of projects including mining, metal refining, and smelting; reservoirs, marinas, power generation and transmission, LNG import terminals, gas pipelines, highways, transit, housing, parks, military facilities and industrial development projects.
- Public participation including the development of innovative, collaborative stakeholder engagement programs and consensus-based public participation processes.
- Regional environmental planning including river basin studies, forest management plans, wildlife corridors, and natural resource management plans for parks and preserves.

Education

- Master of Environmental Management, Duke University, 1981
- Bachelor of Arts, Biology, Gettysburg College, 1978

Key Industry Sectors

- Mining
- Power
- Financial
- Government

Key Projects

Oyu Tolgoi Copper Mine IESC, Mongolia
Project Director serving as Independent Environmental and Social Consultant for the lenders (IFC, EBRD, EDC, Standard Chartered, BNP Paribas) for the world's largest undeveloped copper-gold project located in the Gobi Desert. Project involves both open pit and underground mining using block caving method with an initial capacity of 110,000 tons per day of ore, which will increase to at least 158,000 tpd. Copper concentrate to be exported by truck. Key issues include Potentially Acid Generating waste rock and tailings, water use and availability, impacts to vulnerable herder families and effects on several globally endangered mega-fauna. Evaluating ESIA, ESMP, and ESAP in terms of IFC PS, Equator Principles and EBRD Environmental Requirements. Responsible for helping lenders manage financial and reputational risks for largest mine financing project in history (US$3B project).

NorthMet Mine EIS, U.S.
Served as water resource lead, overall EIS technical coordinator, and strategic advisor for development of an EIS for an open pit 32,000 tpd polymetal sulfide mine in Minnesota as Third-party Contractor for the US Army Corps of Engineers, US Forest Service, and MN Department of Natural Resources, with the active involvement of USEPA and US Fish and Wildlife Service. Project involves subaqueous disposal of reactive waste rock and reuse of a brownfield taconite tailings basin. Oversaw development of comprehensive EIS including rigorous alternatives and cumulative effects analyses.

Global Alumina (GAC) Bauxite Mine and Alumina Refinery Project, Guinea.
Project Director providing Equator Principle Review and Lender Advice for Global Alumina Project (GAC) in Guinea. Conducted an Environmental and Social Due Diligence and provided investment advice to a consortium of 17 lenders including IFC on the feasibility of lending and potential environmental & social risks. The GAC project includes the development of a mine, port and alumina refinery in Sangaredi and Kamsar areas of Guinea. Assessed the adequacy of the Resettlement Action Plan and subsequent resettlement activities as well as advised on Biodiversity Action Plan to ensure that the chimpanzees in the mine area are protected. For a period of two years ERM specialists reviewed the project activities, advised the lender consortium and provided technical assistance.

Land Use Compatibility Study, Canada.
Technical advisor for evaluation of potential noise and vibration effects from an existing mine on a proposed hospital and college site on behalf of the Iron Ore Company of Canada.

Nkamouna Mine ESDD, Cameroon.
Senior Technical Advisor for an Environmental and Social Due Diligence/ Equator Principles review for a proposed cobalt-nickel-manganese mine in Cameroon on behalf of the lenders (Standard Chartered among others). Key issues addressed include biodiversity and effects on indigenous peoples (i.e., the Baka, a pygmy tribe).

Newmont Meridian Gold Mine Social Strategy, Suriname.
Project Director for developing social strategy for proposed gold mine in eastern Suriname in preparation for mineral agreement negotiations with government.

Cerrejon Coal Mine, Colombia.
Serving as Project Director for an independen t evaluation of a proposed expansion of the world's largest open pit bituminous coal mine in the world. Addressing effects on environment, neighboring villages, and downstream indigenous lands.

Suralco Alumina Refinery Expansion ESIA, Suriname.
Serving as Project Director for the development of an ESIA evaluating the environmental and social effects of proposed alumina refinery modifications required to accommodate a new bauxite source, as well as expansion of the bauxite residue disposal areas. Includes stakeholder engagement, social baseline surveys, and development of E&S Management Plans.

Alcoa-Alcan Alumina Refinery Project, Guinea.
Project Director for several components of a proposed alumina refinery near Boke in Guinea. Coordinate the preparation of a Health Impact Assessment for the project and also directed a Worker Camp Siting Workshop for the project proponents.

Nassau Plateau Bauxite Mine ESIA, Suriname.
Serving as Project Director for baseline studies and preparation of an ESIA for a bauxite mine to meet both Suriname and international standards for Alcoa. Key issues include effects on endangered fish, habitat fragmentation, and water quality. Coordinating stakeholder engagement with local Maroon and Amerindian communities.

Greenland Aluminum Smelter/Hydropower Project EIA.
Project Director for development of ESHIA for an integrated hydropower, transmission line, aluminum smelter, and port complex in southwest Greenland. Coordinating with Greenland Home Rule Government on a Strategic Environmental Assessment, overseeing baseline environmental and social studies, managing stakeholder engagement program, and integrating a sustainability initiative into the ESHIA process.

Beni Saf Aluminium Smelter, Algeria.
Technical Advisor for ESHIA for 1.2 Mtpa aluminum smelter in Algeria for Dubal. Provided advice regarding air emissions, spent pot liner disposal technology, and issues regarding desalination plant.

Community Development Agreements, World Bank.
Project Director for developing a framework for Community Development Agreements for mining projects in developing countries for the World Bank. Case studies conducted in Ghana, Papua New Guinea, and Chile.

East Iceland Sustainability Initiative.
Project Director for project assessing the sustainability of a controversial hydropower and aluminum smelter project in a rural area of Iceland. Assisting Alcoa in the development of an overall corporate sustainability framework, as well as specific environmental, social, and economic indicators and metrics.

Chatham Smelter ESHIA, Trinidad.
Project Director for development of ESHIA for 341,000 metric tons per annum aluminum smelter for Alcoa in southwest Trinidad. Coordinated social baseline studies addressing livelihoods and resettlement concerns, developed successful stakeholder engagement strategy and community meetings for very controversial project, and initiated preparation of ESHIA before Alcoa decided to withdraw the project.

Massena Aluminum Smelter Modification, USA
Project Director for conversion of older smelter from Soderberg to pre-bake technology, including improvements in air emissions, SPL generation, and wastewater discharges.

Garrett County Mine (MD) Expert Testimony, USA.
Testified as an expert witness regarding downstream water quality and fishery effects of disturbance/ removal of high sulfide rock overburden.

New London Mine Environmental Assessment, USA.
Project Director for an Army National Guard EA evaluating alternatives for mitigating sedimentation from the abandoned New London Mine on Chorro Creek within Camp San Luis Obispo, which provides critical habitat for the federally listed steelhead trout.

Western Maryland Acid Mine Drainage Mitigation Project.
Project Advisor evaluating environmental and economic cost effectiveness of using fly ash/ limestone stabilizer mix to seal abandoned mines and minimize acid mine drainage.

Zekiah Swamp (MD) Sand and Gravel Mining Impact Study.
Project Manager for study evaluating cumulative effects of sand and gravel mining on hydrology supporting regionally significant Zekiah Swamp wetland complex.

Jamalco Port Reconstruction Review, Jamaica.
Project Director for an environmental review of alternatives for reconstructing the Jamalco port facilities that were destroyed in Hurricane Dean for Alcoa. Evaluated effects of trestle and causeway designs on benthic habitat, sediment transport, and fish in support of an application to the Jamaica National Environment & Planning Agency.

Crown Landing LNG Project, U.S.
Project Manager for a $1.4B and 1.2 BCF/ D LNG import terminal for BP consisting of a marine terminal and an on-shore regasification facility. Responsible for preparing the Environmental Report for FERC, and federal and state permitting. Responsible for insuring project was consistent with BP's sustainability and biodiversity corporate principles.

Inter-American Development Bank (IDB) Support Services Contract.
Project Director for two multi-year task order contracts with the IDB (one for private sector financing and one for public sector projects) providing environmental and social impact review and assessment for a variety of projects including: geothermal power plant in Bolivia, an electric transmission line in Ecuador, and a highway in Ecuador.

Millennium Challenge Corporation (MCC), multiple countries.
Program Director for 5-year, $60M contract with MCC to provide independent engineering and environmental evaluation and monitoring of infrastructure projects in nearly 30 "compact" countries around the world. Initial Task Order is for a highway and bridge project in Mongolia.

Chacayes Hydroelectric Project, Chile
Project Director for conducting an Environmental and Social Due Diligence relative to the Equator Principles on behalf of the lenders for a 80 MW hydropower project in Chile. Hired to conduct compliance monitoring for duration of construction.

Chaglla Hydropower Project ESS, Peru.
Project Director for preparing an Environmental and Social Strategy and Environmental and Social Due Diligence documents for the IDB as part of the overall Project financing for a 406 MW hydropower project.

Pando – Monte Virio Hydropower Project, Panama.
Project Director for construction and operation phase monitoring to ensure project complies with lender requirements, IFC performance standards, Panamanian regulations, and the project's E&S Management Plan and E&S Action Plan on behalf of the lenders, which include the IDB, IFC, and GED.

SIEPAC Construction Phase Monitoring, Central America.
Project Director for construction phase environmental and social monitoring on behalf of the IDB for the SIEPAC transmission line project in Panama, El Salvador, and Guatemala.

Red Vial No. 4 - OHL Concessions/Auto Piste del Norte, Pativilca to Salavery, Peru
Project Director for Environmental and Social Due Diligence per the Equator Principles and E&S Lender's Monitoring project for this approximately 290-km-long highway improvement and construction concession project on the north coast of Peru. After successful completion of ESDD project in 2009, ERM was contracted by the Lender Group (CA-CIB, CAF and BCP) for the multi-year environmental and social monitoring of the project.

St. Lawrence-FDR EIS, U.S.
Project manager for the relicensing of one of the largest (912 MW) hydroelectric projects in the eastern U.S. Key issues included fishery and recreation.

Global City Indicators Initiative.
Project Manager for innovative effort to develop a set of indicators to help cities measure, report, and improve their performance in providing city services and enhancing the quality of life for its residents for the World Bank with funding from the Government of Japan. Coordinated with partner cities from Brazil, Colombia, Canada, and the US.

Camisea Block 56 Gas Field and Pipeline EIA, Peru.
Project Director for EIA evaluating the effects of developing three gas fields, 30 km of gas flowlines, and the Malvinas gas plant in Peru for Hunt Oil/ Pluspetrol. The EIA is being developed to meet Inter-American Development Bank standards.

Watershed Management in El Salvador.
Invited by the U.S. State Department as the principal speaker for an Earth Day conference on integrated watershed management and sustainable development in El Salvador. Participants in the conference included federal ministry representatives, NGO leaders, university professors, and the media.

Xacbal Hydroelectric Project, Guatemala.
Project Director for environmental and social due diligence review of a 94 MW hydropower and 125 km transmission line project on the Xaclbal River in northern Guatemala for the Inter-American Investment Corporation (IIC). Key issues focused on ecological base flows, compensation for land acquisition, community investment program, and overall project sustainability.

Nam Sane 3 Hydroelectric Project EIA, Lao PDR.
Technical Advisor for an EIA of a proposed 85 MW hydropower project in rural northeast Lao PDR. Key issues included resettlement of approximately 2,000 people and effects on downstream fisheries and villages.

Kalivac Hydroelectric Project, Albania
Senior technical advisor for an ESIA for a proposed 100 MW store and release hydropower project with a concrete face rockfill dam on the River Vjose in southern Albania. This will be the first dam on the river so key issues included effects on upstream fish passage, environmental base flows, sediment transport, resettlement, and downstream water users.

John Gangemi

Mr. John Gangemi is a Consultant within ERM, and has 25 years of experience conducting scientific investigations on river and lake environments. As a river ecologist, he has served as a national director of river conservation programs, recreational navigability expert, and regulatory expert. He has performed scientific studies for clients in the hydroelectric, timber, oil and gas, and mining industries as well as non-governmental organizations, university research facilities and governmental agencies throughout the United States.

Mr. Gangemi has extensive experience in the development and execution of river ecological studies tied to regulatory proceedings. His expertise includes fisheries, aquatic entomology, periphyton, limnology, hydrology, water quality, and amphibian studies.

Mr. Gangemi is well-versed in the regulations and permitting procedures associated with the Federal Power Act, National Environmental Policy Act, Endangered Species Act and the Clean Water Act. He has been involved in the licensing of over 100 hydroelectric projects in the U.S. He is skilled in the art of stakeholder engagement and establishing frameworks for collaborative proceedings.

Mr. Gangemi is a nationally recognized expert in the development and implementation of recreation instream flow studies. He has provided in-house training to staff at the Federal Energy Regulatory Commission (FERC) on the proper design, implementation and data analysis for recreation instream flow studies. His studies integrate quantitative aquatic science investigations with the social surveys of user groups resulting in holistic reports that effectively balance resource protection with user preferences. He has performed over 40 recreation instream flow studies at FERC projects.

Professional Affiliations & Registrations

- American Fisheries Society
- North American Benthological Society
- River Management Society
- Northwest Hydropower Association Board of Directors (2008-2011)
- ISO 14001 Lead Auditor, AQS
- OHSAS 18001 Lead Auditor, BSI

Fields of Competence

- River and aquatic ecology investigations
- River recreation planning and studies
- Regulatory permitting and compliance
- Stakeholder engagement and collaborative frameworks

Education

- M.S. Environmental Studies, University of Montana, 1991
- B.A. Natural History, Prescott College, 1984

Languages

- English, native speaker

Key Industry Sectors

- Hydropower
- Oil & Gas
- Mining
- Forestry

Honors & Awards

- National River Conservation Award, 2000
- Green Paddle Award, 1999

Key Projects

Expert Witness for Enloe Hydroelectric Project. FERC No. 12569, Okanogan PUD, Oroville, WA, 2012-2013.
Served as expert witness on aesthetic and recreation study methods and resource evaluations before the WA Pollution Control Hearing Board on behalf of Okanogan Public Utility District. Stakeholders challenged the 401 certificate for the Enloe Hydro project, in part, on the grounds that 401 failed to protect aesthetic and recreation instream flows and the WA Dept. of Ecology failed to do proper studies to quantify aesthetic and recreation instream flow needs to support minimum instream flows in the 401. Performed review of FERC record for licensing process and stakeholder engagement, reviewed 401 certification process, evaluated aesthetic and river recreation resources in the project bypass reach, developed expert testimony on aesthetic and river recreation resources for the Similkameen River and evaluated the studies performed to investigate these issues in the FERC license process and 401 certification.

Terrestrial Wildlife, Wetland and Vegetation Studies, Grant Lake Hydroelectric Project, FERC No. 13212, Homer AK, 2012-2013.
Project manager for terrestrial wildlife, wetland and sensitive plant studies for new 5 megawatt hydroelectric project being developed by Homer Electric Association, an Alaska electric cooperative. Wildlife studies included large mammals (moose, bear, dall sheep, mountain goats) as well as small furbearers, land and water birds, and raptors. Wetland studies mapped existing wetlands in project area and identify wetland acres with potential direct and indirect project impacts. Vegetation studies mapped vegetation types including sensitive plants in project area. Study results will be incorporated into 2014 FERC license application.

Aesthetic Flow and Visual Resource Study, Sunset Falls Hydroelectric Project, WA, 2012-2013.
Principal investigator for aesthetic flows and visual resources study for the proposed Sunset Falls hydroelectric project in Washington being developed by Snohomish County Public Utility District No. 1. Investigated aesthetic flows for two waterfalls potentially affected by project operations. Created photomontages for flows and project infrastructure including diversion dam, intake structure, flowline and powerhouse. Responsible for study plan development, stakeholder engagement, Aesthetic Flow and Visual Resource Workshop, data analysis and reporting.

Recreation Instream Flow Study, Susitna-Watana Hydroelectric Project, AK, 2012-2013.
Principal investigator for recreation instream flow study for the proposed Susitna-Watana hydroelectric project in central AK being developed by Alaska Energy Authority. Responsible for study development, characterizing river recreation opportunities on the Susitna, identifying user groups, stakeholder engagement, field study, data analysis and reporting. Final report characterized river recreation opportunities, instream flow preferences for respective user groups and potential operations to mitigate project impacts.

ESA Section 7 Consultation for Whitefish In-line Hydroelectric Project.
Regulatory and compliance specialist for existing for FERC hydroelectric project undertaking capital project to increase generation capacity. Responsible for mapping regulatory permitting requirements and documenting compliance with local, state and federal agencies. ESA section 7 consultation for listed species required as part of capacity upgrade.

FERC Licensing for Cascade Creek 70 Megawatt Hydroelectric Project, Petersburg, AK, 2010. Resource Studies
Principal investigator for baseline studies for new hydroelecrtric project in southeast AK. Responsible for the development, implementation and reporting for fisheries, wildlife, and cultural resources as well as the ESA Section 7 Consultation and Biological Evaluation and Biological Assessment for sensitive species on the Tongass National Forest. Served as applicant's lead scientist working with state and federal agency staff from respective resource disciplines. The license application, submitted to the Federal Energy Regulatory Commission, served as the NEPA document evaluating and mitigating potential impacts from the proposed hydroelectric project.

Spokane River Hydroelectric Project, FERC No 2545, Avista Utilities, Spokane, WA.
Principal investigator representing Avista's interests in a post-license settlement agreement study investigating aesthetic flow requirements prescribed in the FERC license. Helped Avista successfully reduce the daily aesthetic flow release requirement at Upper Falls Dam from 500 cfs to 300 cfs recouping significant lost generation revenue for the utility.

Prospect Hydropower Project Recreation Instream Flow Study, Jackson County, OR, 2008–2011.
Principal investigator for post license whitewater flow study and recreation access plan required in the new FERC license. Quantified whitewater flow preferences, fishery effects and recreational access at the Prospect Hydropower Project, FERC No. 2630, located on the Rogue River in Oregon. Submitted annual reports and final report to FERC for the three-year investigation.

Water Quality Sampling and Analysis Plan, Riverton, WY, 2010–2011.
Principal author for Aquatic Sampling and Analysis Plan investigating baseline/ existing condition for water quality, aquatic organisms and aquatic habitat in a 40 mile stream corridor. The purpose of the project was to evaluate and determine possible effects of product water discharges from natural gas production in central Wyoming. Regulatory coordination was a critical factor in the acceptance and implementation of the long term monitoring effort. Also responsible for longitudinal site selection and reference sites as well as training field staff on sampling techniques.

Upper Jefferson TMDL Planning Area Water Quality Monitoring, Jefferson County, MT, 2010-2011.
Principal investigator for water quality monitoring project for a TMDL for nutrients, metals, and chlorophyll a for MT Department of Environmental Quality (MT DEQ). Developed and implemented the Sampling and Analysis Plan, including data collection at 30 sites, QAQC, data analysis, reporting and data upload to State and federal water quality database. Served as primary contact with MT DEQ.

Instream Flow Proceeding, Pee Dee River, SC, 2009-2010.
Expert witness on instream flow study methods for legal proceeding associated with hydroelectric project on the Pee Dee River in South Carolina. Drafted critical review of instream flow studies conducted as part of the FERC licensing proceeding. Provided testimony on proper study design, field implementation, analysis and reporting for instream flow studies. Testified as lead expert witness.

Lower Gallatin TMDL Planning Area Water Quality Monitoring, Gallatin County, MT, 2008-2010.
Principal investigator for two-year water quality monitoring project for a TMDL for nutrients, E. coli and chlorophyll a for MT DEQ. Developed and implemented the Sampling and Analysis Plan, trained and supervised field crew for data collection at 80 sites, QAQC, data analysis, reporting and data upload to State and federal water quality database. Served as primary contact with MT DEQ.

Green River Recreation Instream Flow Study, Tacoma, WA, 2007–2009.
Principal investigator for Tacoma Public Utilities investigating the effects of regulated flows on recreation and fisheries downstream of Howard Hanson Dam on the Green River. Howard Hanson Reservoir is managed by the Army Corps of Engineers as a flood control dam during the winter and spring then shifts to a water storage reservoir in the summer and fall seasons. Flow regulation coupled with downstream diversions for municipal water supplies have altered the timing and reduced instream flows resulting in impacts to flow dependent recreation and anadromous fisheries. Presently, instream flows are shaped by downstream anadromous fishery needs and municipal water demand. Two endangered salmon species, chinook and steelhead, are present in the Green River. The goal of the study was to define whitewater flow preferences and integrate these flow preferences into an annual reservoir management plan balanced with the needs of the anadromous fishery, flood control and municipal water storage. The study design incorporated an internet survey to capture boater use and record flow preferences throughout the boating season, scheduled survey events and focus group sessions. The final report identified water management strategies for the Green River below Howard Hanson Reservoir including regulated releases for protection of endangered fish species and habitat, recreation flows as well as reservoir storage for municipal water supplies in the Tacoma area and flood control.

Black Canyon Variable Flow Regime Monitoring Program, Grace, ID, 2005–2012.
Principal investigator for Long-term Monitoring of Whitewater Flows on the Bear River. Developed the study to examine the effect of the whitewater flow regime on river channel shape, substrate and aquatic biota associated with PacifiCorp's Bear River Hydroelectric Project (FERC No. 20) in southeast Idaho. Their new license, issued in 2003, required them to implement periodic whitewater flows and study the biological effects associated with variable flow regimes. These releases will occur at Grace Hydropower Facility in the 6.2 mile reach known as the Black Canyon between Grace Dam and the powerhouse. Specifically the

monitoring plan included investigation of: 1) Macroinvertebrates—population trends, diversity and community indices; 2) Organic Matter Ash-Free Dry Weight (AFDW); 3) Periphyton—chlorophyll concentration and biomass; 4) Fisheries—population trends, community composition, fish condition; 5) Filamentous Algae—density; and 6) Channel Morphology—shape and substrate composition.

Kootenai River Varial Zone Recolonization Study, Libby, MT, 2006-2009.
Principal investigator for research contracted by Montana Fish, Wildlife and Parks to investigate recolonization rates of benthic macroinvertebrates in the Kootenai River varial zone downstream of Libby Dam. Study included time series sampling of the benthic macroinvertebrate community throughout the summer season to quantify colonization rates. Congruent benthic sampling in the permanently wetted zone under base flow conditions served as a reference. Varial zone benthic samples were obtained over a 60-day period in five-day increments enabling measurement of colonization rates. Comparisons include benthic abundance, species richness, similarity indices and other metrics. Kootenai benthic colonization data will be used to test assumptions in the benthic biomass model (RivBio). Prior to this study, this model assumed a 47-day sigmoidal curve for recolonization and recovery to pre-disturbance conditions based on estimates obtained from scientific literature. RivBio model outputs will be used to assess the effect of various Libby Dam operation strategies on lotic energy pathways.

Bigfork Hydroelectric Project Synoptic Temperature Study, Flathead County, MT, 2009.
Principal investigator responsible for development and implementation of synoptic temperature study at PacifiCorp's Bigfork Hydropower Project, FERC License No. 2652. FERC license required a longitudinal temperature study of the Swan River and project impoundment in the 401 certificate. Drafted a study plan encompassing continuous sampling throughout the summer season at a combination of riverine sites and project impoundment sites longitudinally along the Swan River. The project impoundment sites required vertical profiles of temperature. Conducted comparative analysis of water temperatures at respective sites for diurnal cycles and 7-day running averages. Submitted the data analysis and report to PacifiCorp in the fall of 2009 for regulatory review by the FERC, MT DEQ, MT FWP and USFWS.

Chuitna Coal Aquatic Baseline Study Investigations, Beluga, AK, 2006-2009.
Aquatic Ecologist for a NEPA process for the permitting of the Diamond Chuitna Coal Mine. Collection of extensive baseline data on the freshwater aquatic biology (fisheries, stream habitat, periphyton, benthos, lake habitat, and zooplankton) within and adjacent to the proposed mine project area. Data collected will be used by the U.S. EPA in an Environmental Impact Study to make a decision on permitting development of the mine. Methods include: Fish population estimates obtained through intensive minnow trapping throughout the basin from March through November 2006; adult population estimates obtained through aerial and ground surveys of spawning adults; periphyton and benthic macroinvertebrates sampled in March, June, July and September. Periphyton AFDW and Chlorophyll analyzed to assess primary productivity. Benthos sampled using surber sampler. Benthic density, species richness, and numerous community indices analyzed to assess benthic community. Fourteen representative reaches of stream habitat surveyed with rod and level to map existing conditions for future stream reconstruction. Lake habitats sampled for resident fish species, zooplankton and macroinvertebrates.

Fish Stranding Study Design, Grace, ID, 2007.
Scientific advisor for PacifiCorp assisting with development of studies required in the FERC license for the Bear River Hydropower Projects, FERC License No. 20. Primary author for study plan for investigation of fish stranding potential in the Black Canyon of the Bear River, Idaho. Plan included three hypotheses for testing interaction between dam release volume, fish community composition and season for release. Power analysis using data obtained from other stranding studies established number of study plots needed to detect statistically significant difference between flows and seasonality. Stranding results from individual survey plots was extrapolated to the 6.2-mile Black Canyon using a Fish Stranding Index that scored the vulnerability of stream banks to strand fish based on area, bank slope, substrate composition, and vegetation. Study will be used in PacifiCorp's ongoing license reporting requirements.

Confederated Salish and Kootenai Tribe Canal Seepage Study, Lake County, MT, 2009.
Principal investigator quantifying canal seepage losses for the Flathead Indian Irrigation Project (FIIP). The Montana Reserved Water Rights Compact Commission

(RWRCC) is currently engaged in negotiations with the (CSKT) quantifying the Tribes' federal reserved water rights. Negotiators identified a need to conserve water on the FIIP. Quantified the magnitude of irrigation canal seepage on twelve canal segments representative of soil conditions and canal construction on the FIIP. Established stilling wells with continuous recording depth meters at upstream and downstream locations. Staff gages and cross-sectional areas were surveyed for developing rating curves. Canal seepage losses were evaluated concurrently in 2-week increments throughout the irrigation season by measuring inflow and outflow on twelve selected canal segments within the Mission and Jocko Valleys. Documented significant conveyance losses where the unlined canals crossed the permeable native soils. Presented RWRCC with complete data set and hydrologic analysis for the 12 canal segments spanning the 2009 irrigation season. Results will be used, in part, in negotiations for quantifying federal reserved water rights for the CSKT.

Draft Environmental Assessment: Paul Taylor Fishing Access Site, Flathead County, MT, 2007-2012.
Principal author for comprehensive Environmental Assessment (EA) in compliance with the Montana Environmental Protection Act (MEPA) with the goal of evaluating potential impacts associated with the development of a FAS. Previous efforts to develop a FAS on Lake Five were challenged successfully in a lawsuit filed by adjacent landowners. Conducted two public open house-type meetings subject to the public meetings laws of the State of Montana and compiled public comment on alternatives offered in the Draft EA. Completed the Draft EA detailing alternatives analysis, including findings of impact to the human and physical environment.

FERC Recreation Instream Flow Training, Washington, DC, 2005.
Lead Instructor responsible for development and delivery of instructional materials for two-day course for FERC staff in Washington, DC on the design, execution and evaluation of recreation instream flow studies. Recreation instream flow studies assess navigability, safety, and the quality and quantity of instream flows for recreation. In addition, recreation flow studies take into consideration ecological resource needs such as instream flows for fish, wildlife, channel maintenance and riparian environments. In addition, these studies balance competing consumptive water uses such as power, irrigation, or other uses. Recent Comprehensive Publication: Whittaker, D., B. Shelby and J.T. Gangemi. 2005. Flows and Recreation: A Guide to Studies for River Professionals. Hydropower Reform Coalition.

Whitefish River Floodplain Delineation, Flathead County, MT, 2007.
Project manager for a hydrologic assessment and hydraulic analysis along approximately 0.7 miles of the Whitefish River at the Riverbend Village property. Analysis included performing 1-dimensional hydraulic modeling using HEC-RAS. Hydraulic modeling was conducted to delineate the limits of the 100-year floodplain. Additional tasks included completing FEMA's Letter of Map Revision (LOMR) process and flood frequency analysis.

Johnson Creek Floodplain Delineation, Lake County, MT, 2007.
Project manager for a hydrologic assessment and hydraulic analysis along approximately 0.3 miles of Johnson Creek at the Kootenai Lodge property. Analysis included performing 1-dimensional hydraulic modeling encompassing a historic rock bridge and multiple culverts. Hydraulic modeling was conducted to delineate the limits of the 100-year floodplain. Additional tasks included building a stage-discharge rating curve, flood frequency analysis and completing FEMA's Letter of Map Revision (LOMR) process.

Fisher River Floodplain Delineation, Flathead and Lincoln Counties, MT, 2006.
Project manager for a hydrologic assessment and hydraulic analysis along approximately three miles of the Fisher River at the Tom Rae property and Fisher Pines development. Analysis included performing 1-dimensional hydraulic modeling encompassing two bridges, multiple culverts and adjoining tributaries. Hydraulic modeling was conducted to delineate the limits of the 100-year floodplain. Additional tasks included completing the Letter of Map Revision (LOMR) process and flood frequency analysis.

Swan River Streambed and Bank Alteration Permitting, Flathead County, MT, 2007.
Project manager for a project entailing replacement of over 700 lineal feet of deteriorating retaining walls and docks on the Swan River in Bigfork Bay. Responsible for obtaining project permits and environmental oversight during construction. Permitting included an ACOE 404 permit, MT FWP 124 Stream protection permit, MT 310

Streambed and Bank Alteration permit, and MT DEQ 318 turbidity permit.

Bigfork Hydropower Project Recreation Facilities, Flathead County, MT, 2006.
Project manager for permitting, design and construction of four recreation facilities at PacifiCorp's Bigfork Hydropower Project, FERC License No. 2652. Recreation facilities included a reservoir boat launch, nature trail parking area, whitewater boater parking and access to river across project canal system, and day use park complete with host pad for 24-hour security. Each facility included signage. Permitting included an ACOE 404 permit, MT FWP 124 Stream protection permit, MT 310 Streambed and Bank Alteration permit, and MT DEQ 318 turbidity permit.

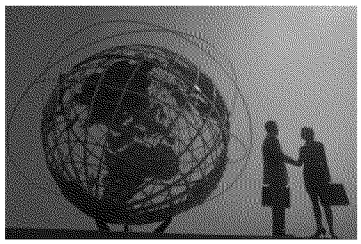
Montana Department of Fish, Wildlife and Parks, Missoula, MT, 1991.
Fisheries Technician responsible for designing and implementation of a creel survey. Responsibilities included aerial counts of anglers, interviews, computer data entry, and analysis as well as minor enforcement.

Publications

- Whittaker, D., B. Shelby, and J. Gangemi. 2005. Flows and Recreation. A guide to studies for river professionals. Hydropower Reform Coalition. Washington DC.
- Gangemi, J.T. 2004. Sequential Approach for Assessing Whitewater Recreation Opportunities at FERC Hydropower Projects. Proceedings from the River Management Society Bi-annual meeting, Lake Tahoe, CA.
- Hauer, F. R., G. C. Poole, J. T. Gangemi and C. V. Baxter. 1999. Large Woody Debris in Bull Trout Spawning Streams of Logged and Wilderness Watersheds in Northwest Montana. Can. J. Fish. Aquat. Sci. 56:915-924.
- Frissell, C.A., J. Doskicil, J. T. Gangemi and J. A. Stanford. 1995. Identifying priority areas for protection and restoration of riverine biodiversity: A case study in the Swan River basin, Montana, USA. Report prepared for the Pacific Rivers Council, Eugene, Oregon.
- Hauer, F. R., J. T. Gangemi and J. A. Stanford. 1993. Long-term influence of Hungry Horse Dam operation on the ecology of macrozoobenthos of the Flathead River. Open File Report 133-94.
- Hauer, F. R., J. A. Stanford and J. T. Gangemi. 1991. Effects of stream regulation in the upper Missouri River. Flathead Lake Biological Station. Open File Report 116-91, 61+ pp. RPT 116-91
- Gangemi, J. T. 1989. Impact of Acid Mine Drainage on Benthic Macroinvertebrates (Plecoptera) in a Montane Stream pg. 645-653 in proceedings "Symposium on Headwaters Hydrology", W. W. Woessner and D. F. Potts (eds). American Water Resources Association, Bethesda, Maryland.

Paul Krause, PhD

Partner



Dr. Paul Krause is a partner with ERM, and has 22 years of experience in the fields of marine and aquatic ecology, toxicology, environmental impact analysis, environmental risk assessment, modeling, and regulatory permitting and negotiation as an academic researcher and professional environmental consultant.

Dr. Krause is an internationally recognized expert in marine ecology. He specializes in issues relating to the effects of oil and gas developments worldwide. His particular expertise revolves around marine toxicology and ecology related to the discharge of oil-related effluents and the effects of development and abandonment activities on marine populations and communities. Dr. Krause has managed large ecological assessments of benthic and intertidal receptors throughout the western United States, Gulf of Mexico, the Pacific Islands, Australia, and West Africa. Through his support of the oil and gas industry his ecological projects have involved oil effluents and drilling issues, permitting issues, mine tailing sites, large river benthic community studies, coral and rocky reef studies, wetlands and intertidal mudflat studies

Dr. Krause is an accomplished ecologist and toxicologist and has served as the director of a large biological laboratory. He has designed and managed large ecological investigations involving both field (*in situ*) and laboratory tests. His experience includes designing ecological risk assessments and ecological habitat assessments in aquatic and marine habitats. He has managed the development of large projects through the CEQA and NEPA process, developed EIR/ EIS reports, project applications, and project permitting throughout the US. Dr. Krause has also supported international impact studies through the ESHIA process.

Additionally, Dr. Krause has managed projects for all major ports in California (Long Beach, Los Angeles, Oakland, San Francisco, and San Diego, US Navy) as well as the Ports of Portland, Tacoma, and Seattle. His projects have included sediment risk assessments, dredge studies, new construction projects, and beneficial reuse issues.

Dr. Krause has a strong background in basic research as well as consulting. Much of his academic research has been dedicated to studying the ecological effects of municipal and industrial effluents on both benthic and water column organisms. His research efforts have spanned from long-term effects of oil production to the spatial and temporal distribution of toxicity around municipal effluent sources. Dr. Krause has authored several peer-reviewed papers and given many talks at professional meetings. He is the recipient of a National Academy of Science post-doctoral fellowship with the National Biological Survey, and a University of California Toxic Substances Research and Teaching Fellowship while at UC Santa Barbara. He has experience in such diverse areas as analytical chemistry, technical writing, and computer programming, and is a skilled bio-statistician familiar with all major statistical computing packages such as SAS, SYSTAT, and SPSS.

Professional Affiliations & Registratio ns

- International Association of Impact Analysis
- Society of Environmental Toxicology and Chemistry, Past editorial board member for Environmental Toxicology and Chemistry
- Southern California Chapter, Society of Environmental Toxicology and Chemistry, Member of Elected Board of Directors 2002-2004, 2009-2011; Current Vice President
- Ecological Society of America
- Society of Petroleum Engineers
- Journal of Experimental Ecology and Marine Biology – Editorial Board
- Archives of Environmental Contamination and Toxicology – Editorial Board

Fields of Competence

- Marine Ecology
- Ecotoxicology
- Sediment Toxicology
- Natural Resource Damage Assessment
- Ecological Risk Assessment
- Environmental Impact Studies
- Contaminated Site Investigations
- Oil Spill Response and Cleanup

Education

- Ph.D. Ecology/ University of California, Santa Barbara, CA, 1993
- M.S. Biological Sciences, California State University, Long Beach, CA, 1987
- B.S. Marine Biology, California State University, Long Beach, CA, 1984

Languages

- English, native speaker
- German, reading

Key Industry Sectors

- Oil and Gas
- Ports & Harbors
- Metals & Mining
- Power

Honors & Awards

- ARCADIS Chairman's Health and Safety Team Award, 2010
- ARCADIS – Health and Safety Innovation Award, 2007
- British Petroleum/ Atlantic Richfield – Diamond Award Finalist for Outstanding Health and Safety Performance, 2006
- Certified Professional Ecologist – Ecological Society of America, 2006
- Service Award – Southern California SETAC Chapter, 2002 – 2004
- Customer Service Award – MEC Analytical Systems, Inc., 1997
- National Research Council-National Academy of Science Research Associateship Award, 1993
- University of California Regents Fellowship, 1993
- University of California Toxic Substances Research and Teaching Fellowship, 1989 – 1993
- International Women's Fishing Association Scholarship Award, 1989
- Outstanding Thesis Award, CSU, Long Beach, School of Natural Sciences, 1987

Publications

- Krause, P.R. 2010. A new artificial reef in Santa Barbara, California: An example of environmental enhancement from oil field decommissioning activities. Presented at the Ecological Society of America, 2010 Annual Conference, Pittsburgh, PA.
- Hartley, M.K., P.R. Krause, W.R. Gala, and R.W. Hill. 2010 Decommissioning of offshore platforms: Ecological value to fish resources of leaving shell mounds in-situ as determined through habitat equivalency analysis. Presented at the Ecological Society of America, 2010 Annual Conference, Pittsburgh, PA.
- Krause, P.R., R. W. Hill, W.R. Gala, and S. Larew. 2010. Determining the ecological value of fish resources at platform decommissionin g sites using ROV and trapping techniques in the Santa Barbara Channel, USA. Society of Petroleum Engineers, SPE Journal 2010.
- Krause, P.R., M. Chamberlin, and J.R. Starr 2008. Managing storm water in ports: a non-point source and analysis approach. Presented at the 2008 Ports Environment Conference, Rotterdam, NL Krause, P.R. , L.A. Hostetter, and W.R. Gala. 2008. Habitat Equivalency Analysis (HEA) as a tool to rank environmental project alternatives. Presented at the 2008 Conference on Ecosystem Services. Naples, FL.
- Carr, R.S., P.R.,Krause, and P. Montagna. 2008. Spatial and temporal patterns of toxicity around a municipal-industrial wastewater discharge in Corpus Christi, Texas. In: *Marine Pollution: New Research* Hofer, T.N. (ed). Nova Science Publishers.
- Krause, P.R., and A. Brown. 2007. Ecological development of a newly formed artificial sub-tidal reef community. Proceedings of the 2007 meeting of the Society of Toxicology and Chemistry, Europe. Porto, Portugal.

Key Projects

Impact Assessment and Planning

BP/ARCO, Project Principal/Senior Scientist.
Developed and managed scientific services for the decommissioning of a relic oil pier in Southern California. This included development of permits and monitoring plans for the threatened and endangered species, de-construction activities monitoring, and development of a long-term ecological study of the newly created artificial reef. This project involves CEQA reporting, subtidal monitoring activities and reporting.

Confidential Client, Project Manager/Senior Marine Ecologist.
Developed a decommissioning plan and environmental impact assessment for marine fish populations related to the closure and dismantlement of offshore oil production and transportation facilities in the Islamic Republic of Mauritania.

Clearwater Port, LLC, Principal Scientist.
Developed complex project application package under CEQA for the citing and permitting of an offshore Liquefied Natural Gas (LNG) terminal in the Santa Barbara Channel. Project tasks included detailed plume modeling, terminal NPDES permit applications, and the permitting of a 45 mile LNG pipeline through the southern California Mountains.

Chevron, Project Principal/Senior Marine Ecologist.
Managed the marine sciences and ecological risks associated with the disposition of residual shell mounds from the decommissioning of the 4H oil production platforms located in the Santa Barbara Channel. Led marine science investigations on the mounds, developed political strategy, technical frameworks, and project designs for innovative studies to support the CEQA/ NEPA process and develop the environmentally superior project alternative.

BP/ARCO, Project Principal/Senior Ecologist.
Served as the principal investigator and program manager for the development of the permits necessary under CEQA for the removal of over six miles of abandoned pipelines. Pipelines run across sensitive habitats along the Santa Barbara bluffs. Additionally, supported engineering estimates for the development of innovative approaches to the removal of the pipeline with minimal impacts. Developed HSSE, Fire Control, permit monitoring, and demolition teams.

The Termo Company, Project Principal/Senior Scientist.
Managed a team to develop drilling permits and application packages for the first on-shore drilling project within Los Angeles County in over 25 years. This project involved development of permit packages and evaluation of impacts to local ecology, resident communities, and the public.

Ecological Studies

Exxon Mobil, Project Principal/Senior Marine Ecologist.
Managed the marine resources investigations for ExxonMobil at the Valloy Norway remediation. This project involved complex diver surveys and operations to investigate the presence and extent of acid tar encroachment into the Oslo Fjord. Ecological receptors were also investigated within the region in anticipation of risk determinations.

Chevron, Project Principal/Senior Marine Ecologist.
Assisted in scoping and project development for deep water fisheries studies in the deep offshore waters of the Nigerian coastline. Developed a sampling scope of work to determine fishery resources that included demersal/ benthic, pelagic, and marine mammals. Data will be used by the client and the local government agencies to develop long-term fishery management strategies.

Southern California Edison, Senior Marine Ecologist.
Developed a population model for the white sea bass in southern California. Included interpretation of planktonic record data, collection of fish growth data and computer modeling.

Confidential Client, Project Manager/Senior Ecologist.
Served as the principal ecologist to determine ecological effects on riverine benthic communities from residual PCB in sediments. Project involved interpretation of benthic invertebrate community data sets collected over a multi-year study with synoptic toxicological and chemical data.

Confidential Client, Project Manager/Senior Ecologist.
Served as a litigation expert for stream and bay communities contamination from chromium, PCB and fluoride contamination from groundwater sources. Project involved development of field studies, interpretation of past studies, review and analysis of benthic ecological data, development of litigation support materials and trial demonstrable materials.

Chevron, Principal Marine Ecologist.
Provided expert evaluation of the feasibility of the development of offshore mariculture facilities for the culture of large marketable species such as California halibut, rockfishes, yellowtail, and striped bass. Culture facilities are designed to be deployed onto existing offshore oil platforms as grow-out facilities in conjunction with Hubbs Sea World.

Sediment Investigations

California Sediment Quality Objectives.
Served as a principal toxicologist in the evaluation and development of the proposed framework for establishing sediment quality objectives for the State of California. This included participating in as a member of the Scientific Advisory Committee and evaluation of proposed methods for the evaluation and implementation of objectives to determine the direct and indirect effects of contaminated sediments on ecological receptors.

Port of Portland, Project Manager/Toxicologist.
Provided senior level management for the development of the site characterization and risk assessments associated with an Early Action under CERCLA for the Port of Portland. Lead field sampling, laboratory quality assurance, project management and reporting through the Engineering Estimate/ Cost Analysis (EE/ CA) report.

Pacific Sound Resources Superfund Site, Chemical Quality Control Officer/Toxicologist.
Provided quality control oversight, reporting, development of Sampling and Analysis Plans and Quality Assurance Project Plans, negotiations with regulators, and water quality modeling for the Pacific Sound Resources Superfund Site located in Puget Sound, WA.

US Army Corps of Engineers, San Francisco District, Los Angeles District, and Pacific Division, Program Manager.
Served as the primary contact and manager for multiyear service contracts for several USACE districts. Projects included maintenance dredging projects for over 50 sites throughout California, Oregon, and Hawaii. Managed the disposal and daily operation of the largest contained disposal facility in California at the Galbraith Disposal Area in Oakland California. Developed study designs, field sampling plans, and supervised field and laboratory activities related to permitting of ACOE projects.

Port of Long Beach, CA, Program Manager.
Managed multi-year sediment projects including maintenance dredging, new construction dredging, and Port development projects. Supervised field studies involved in dredging and risk assessment activities related to contaminated sediment issues for the Port. Projects included serving as the program manager for the West Basin, Channel Two, Pier T and Pier S deepening and terminal development projects. Activities included regulatory interactions, sampling plan designs, field studies and laboratory toxicity studies.

Port of Oakland, CA, Program Manager.
Supervised staff in regulatory interactions, sediment quality guideline development, and permitting for routine maintenance dredging and new construction projects for the Port over multiple years. Projects included sediment studies at all Port terminals, supervision of dredging activities, and disposal operations. Served as manager for field activities for the 50-foot deepening project and Middle Harbor re-development that included collection and analysis of over 250 sediment samples.

Port of Los Angeles, CA, Program Manager.
Managed sediment projects for the Port that included sediment sampling, testing, and long-term evaluations. Projects included maintenance dredging, and new construction dredging at various Port properties including municipal marinas, bulk loading terminals, and container terminals. Management tasks included development of detailed management plans for contaminated sediments, regulatory interactions, supervising field and laboratory studies and development of sediment action plans for sites at risk.

US Navy, Project Toxicologist.
Designed field and laboratory studies to investigate sediment quality for the future home-porting of Navy assets in Pearl Harbor, and San Diego.

US Navy SINKEX program, Program Manager.
Managed the long-term study designed to detect toxicity in sediments from sunken Navy target ships at depths of over 2000 feet Designed field study programs, developed innovative protocols, engineered field sampling equipment and provided laboratory support.

US Minerals Management Service, Principal Investigator. Managed the data collection, interpretation, statistical analysis of a long-term deep sea study of the effects of offshore discharge of drilling fluids. This study included placement of settling traps, and *in-situ*

bioassays at a depth of over 600 feet in the Santa Barbara Channel.

Ecological Toxicology/Risk Assessment

U.S. Army, Risk Assessor, Project Manager.
Managed the ecological risk assessment for closure of offshore resources at the Oakland Army Base for the U.S. Army.

Union Pacific Railroad, Risk Assessor/Project Manager.
Ecological risk assessment on effects of residual PCBs and metals on the terrestrial and marine communities in Humboldt Bay, CA, in preparation for a property transfer.

United Nuclear Corp., Risk Assessor/Project Manager.
Ecological risk assessment on effects of mine tailings on a stream community at the Cornucopia mine site in eastern Oregon.

City and County of San Francisco, Department of Public Works and the Port of San Francisco, Project Toxicologist/Project Manager.
Served the Port to provide regulatory support, sediment study plans, field and laboratory services and risk assessment assistance for routine maintenance dredging and development activities.

California State Water Resources Control Board, Project Toxicologist.
Toxic Hot Spot review and sediment quality criteria development for the State of California.

Additional Research Studies

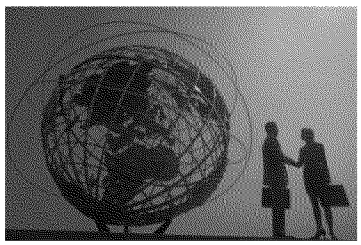
Corpus Christi Bay, TX, Principal Investigator.
Analysis of spatial and temporal distributions of toxicity around a municipal-industrial wastewater discharge in Corpus Christi Bay, Texas. Designed and led field and laboratory studies to characterize waste plumes using sediment pore-water toxicity, water chemistry, and benthic diversity data.

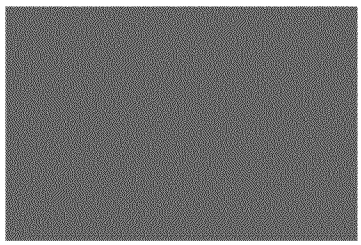
Principal Investigator.
Analysis of the ecological effects of oil-related effluents. Designed and led both field and laboratory studies to investigate effects on reproduction, growth, and development of marine invertebrates from produced water discharges in southern California.

Principal Investigator.
Studies to quantify the level fish mediated, heavy metal importation onto rocky reefs off Catalina Island, CA.

Sinang Lee

Consultant, Health/Social Specialist





Ms. Sinang Lee is a Health/ Social Consultant with an interdisciplinary background in environmental sciences, public health and international development. Her expertise lies in assessing risks and impacts of development projects from an integrated environmental, social and health lens. She has 10 years of experience in engaging various stakeholders in managing environmental health risks and natural resources at the local, national and international levels.

Ms. Lee's diverse projects include integrating health impact assessment (HIA) into US NEPA Review/ EIS and SIA processes, conducting social and health baseline studies, and leading tribal and stakeholder engagement efforts.

Ms. Lee has specific skills in conducting integrated ESHIAs; applying participatory rural appraisal techniques in developing country context; designing social/ health assessment surveys; evaluating quantitative/ qualitative data; and environmental permitting and compliance.

Prior to joining ERM, Ms. Lee worked for State of Washington, Pacific Northwest Agricultural Safety and Health Center, US EPA's Office of International Affairs and US Agency for International Development (USAID). She has presented her work at the International Scientific Conference on Occupational and Environmental Health in Hanoi, Vietnam; and at US EPA's Watershed Management Conference.

Ms. Lee holds a Master of Public Health degree in Environmental and Occupational Health Sciences from University of Washington and a Bachelors degree in Environmental Sciences from UC Berkeley.

Fields of Competence

- Health/ Social Impact Assessments
- Integrated ESHIAs
- Stakeholder Engagement and Public Consultation
- Environmental Site Assessments
- Environmental Regulatory Compliance

Education

- M.P.H. Environmental and Occupational Health Sciences, University of Washington, U.S. 2006
- B.A. Environmental Sciences, UC Berkeley, U.S. 2001

Languages

- English, native speaker
- Khmer, native speaker
- Spanish, intermediate

Key Industry Sectors

- Government
- Agriculture
- Oil and Gas
- Mining
- Manufacturing

Honors & Awards

- UW Graduate School Top Scholar, 2004-2005
- Puget Sound Partners for Global Health Grant Recipient, 2005

Publications

- Fluorescent Tracer Manual: An Educational Tool for Pesticide Safety Educators
  http:/ / depts.washington.edu/ pnash/ FT.php
- Bear-Evans Watershed Temperature and Dissolved Oxygen Total Maximum Daily Load: Water Quality Improvement Report
  www.ecy.wa.gov/ biblio/ 0810058.html

Key Projects

HIA Integration into Point Thomson EIS, Alaska, Confidential, 2010 - 2012. Consultant
Responsible for integrating a state-developed HIA into the proposed project's EIS as part of the NEPA Review process. Provided technical review of State-developed HIA that evaluated health impacts from the proposed oil and natural gas condensate extraction operation.

Social Gap Analysis for Gold Mine and Pipeline Project, Confidential, USA, 2011. Consultant
Conducted a gap analysis to identify gaps in existing social baseline information for the mine project area. Following the data review, a draft social baseline report will be prepared to include a list of data needs to be addressed in future social impact assessments.

Scoping Report and SIA for an Open Pit Rare Earths Metal Mine, Confidential, Greenland, 2011. Consultant
Prepared the scoping report for the project and conducted the stakeholder consultation efforts as part of the Social Baseline Study.

Integrated ESHIA for Offshore Oil and Gas Project, Confidential, Angola, 2011. Consultant
Conducted a high-level assessment of health effects from a proposed offshore oil and gas project on the subsistence fishermen community. Assessment involved review of secondary health data and artisanal fishing survey.

HIA as part of the ESIA for Suralco Nassau Bauxite Mine Project, Alcoa/Suralco, Surinam e 2010 – 2011. Consultant
Completed a HIA for a mine site and road corridor project which involved developing health baseline studies, evaluating the health impacts and identifying mitigations and recommendations. In addition, an interim community health management plan was prepared to address the key community health risks and issues.

Integrated ESHIA for Offshore Minerals Petroleum Project, Confidential, Greenland, 2011.
Prepared a health baseline study, with a focus on the healthcare system and health profile in Greenland, including capacity and services at the municipality and national levels and the implications of a recent healthcare reform.

Social Baseline Study for the Deepwater Horizon Gulf of Mexico, Confidential, USA, 2010-2012.
Collected a comprehensive set of secondary social and health baseline data to understand the key social and health issues associated with oil and gas activities in the Gulf of Mexico. The study is prepared as part of anticipated permitting requirements as well as to meet internal corporate sustainable development priorities.

Best Practices in Community Health and Safety, Inter-American Development Bank (IDB), 2010-2012. Consultant
Supported the development of case studies in managing community health and safety risks and impacts in IDB funded projects in transport, energy, extractive, agribusiness and manufacturing sectors.

Corporate Social Responsibility Training Program, Canada, Barrick Gold Corp, 2010-2012. Consultant
Designed e-learning modules and facilitated workshops to operationalize Barrick's Community Relations Management System throughout its global operations. Training topics include CSR and community engagement.

Complementary ESIA for Hydroelectric Project, Confidential, Nicaragua, 2010. Consultant
Completed an update to the health impact assessment as part of the integrated ESIA. Identified key community health and safety risks associated with the proposed project components. In addition, an early action health management plan was prepared to address the key risks/ impacts identified.

Stakeholder Engagement Tools, Canada, Teck Mining Company, 2010. Consultant
Developed community engagement protocols and guidance documents, including the guidance on How to Build a Community Team, Community Health and Engagement Planning.

Watershed Management Plan, WA State Department of Ecology, 2006-2009. Project Manager
Managed the stakeholder involvement process to engage the Muckleshoot Indian tribe and municipalities in preparing science-based watershed management plans (or TMDLs). Led and facilitated stakeholder advisory groups and public meetings. Effectively communicated technical concepts in reports and presentations for the public.

Pesticide Safety Intervention Tools for Agricultural Workers, Pacific NW Agricu ltural Safety and Health Center, USA and Cambodia, 2005-2006. Researcher
Evaluated the effectiveness of an innovative pesticide safety intervention tool. Designed and tested 17 field trainings using PRA techniques with over 200 farmers in Cambodia. Collected and analyzed qualitative data from critical article reviews, key informant interviews and focus group observations.

Montrose /Palos Verdes Shelf Sediment Cleanup, US Environmental Protection Agency, California, 2003. Community Liaison
Conducted a multi-ethnic angler survey to gather subsistence fish consumption habits of immigrants fishing at a DDT- and PCB- contaminated sediment Superfund site off the coast of Southern California. Results guided the development of a nationally recognized community-based health education and outreach program.

Presidential Water for the Poor Initiative, US Agency for International Development, Washington, DC, 2003-2004. Database Manager
Tracked the indicators of success and progress of the largest Presidential Initiative, *Water for the Poor*. Coordinated with 75 field offices worldwide to collect, under a strict deadline, funding data and case studies for the annual report to Congress and the White House.

Chemicals Information Exchange Network, Central America, US Environmental Protection Agency, Washington, DC, 2002-2003. Project Manager
Collaborated with UN Environmental Program and a Costa Rican NGO to plan 8 technical assistance workshops to build proper chemicals management capacity throughout Central America. Promoted the use of the internet to access proper chemicals information.

San Jose Community Gardens, UC Berkeley Department of Environmental Sciences, CA, 2000-2001. Researcher
Evaluated the social and health benefits of community gardens as perceived among immigrants and American born gardeners. Designed the self-administered questionnaire with translations to Spanish, Vietnamese, and Bosnian. Study promoted the value of community gardens to help immigrants resettle in US towns.

Antimicrobial Properties of Medicinal Plants, Tropical Biology Institute, Costa Rica, 2000. Researcher
Interviewed rural community members in Spanish on the traditional uses of medicinal plants. Tested the antimicrobial properties of tea extracts from two medicinal plants.

Bruce Marsh, P.E.

Mr. Bruce Marsh has extensive experience and strong expertise in domestic and international Environmental Social and Health Impact Assessments, project and risk management, audits/ reviews, permitting, communication & relationships, cost reduction and strategic planning.

Mr. Marsh's project management experience includes schedule and budget management for all phases of mining projects from exploration, baseline, pre-feasibility, feasibility, construction, operation, mine closure and post closure. He has managed multiple significant natural resource development projects including ESHIA, NEPA EIS, permitting, auditing, program reviews, assurance, and stakeholder engagement throughout the world.

Professional Affiliations & Registrations

- Professional Engineer
- Adjunct Professor Arizona State University, School of Sustainability and Earth Sciences
- Member University of Arizona Center for Environmentally Sustainable Mining (CESM)
- Grand Awards Judge ISEF Environmental Management

Education

- MS, Environmental Engineering, Oregon State University, 1980
- BS, Civil/ Environmental Engineering, University of Florida, 1978

Key Industry Sectors

- Mining

Fields of Competence

- **Environmental expert known for integrity, problem solving and impact assessment leadership.**
  - Led major mining operation's Environmental and Social Impact Assessment group
  - Pre-Feasibility environmental and social team leader for large complex Arizona block cave mine.
  - Senior environmental and social team leader for successful Panama Canal third lock expansion achieving +80% approval vote by country.

- **Dedicated manager who keeps commitments focused on critical implications.**
  - Project management for all phases of projects from Exploration, Baseline, Pre-Feasibility, Feasibility, Construction, Operation, Mine Closure and Post Closure.
  - Helped Cyprus Amax and BHP in Arizona with water management and optimization study and permitting. that saved over $100 million in capital and maintenance costs.
  - Led ESIA for a $36 billion project next to sensitive wetland in Dubai delivering approval on schedule.

- **Team leader with excellent risk management and communication skills who meets critical targets by bridging diverse groups.**
  - Developed risk registers and action plans for:
    - Chino Mine, New Mexico
    - Climax Mine, Colorado
    - Morenci Mine, Arizona
    - Safford Mine, Arizona
    - Sierrita Mine, Arizona
    - Miami Mine, Arizona
    - Bagdad Mine, Arizona
  - Negotiated complex consent decree order while leading State superfund site studies and 160 million dollar EPCM team for three mining companies in Miami, Arizona.
  - Mine closure planning to contain costs and develop practical solutions with reasonable timetables.

Key Projects

Owner/Principal: Environmental and Sustainable Solutions, Phoenix, Arizona. May 2012 to present
Support natural resource development projects including ESHIA, NEPA EIS, permitting, auditing, program reviews, assurance, stakeholder engagement. Have worked for Hunter Dickinson with their Curis Resources and Heatherdale companies. Primarily working on the Florence, Arizona Copper Insitu Project but also several small underground mines in Alaska. All projects in the Pre-Feasibility phase and helping to secure state and federal permits and working through a number of complex issues and negotiations with local communities.

Senior Director Sustainable Development: Freeport McMoRan Copper & Gold, Phoenix, Arizona. 2007 to May 2012)
Developed and led new Sustainable Development Department to ensure environmental and social compliance and commitments with company policies and international best practices including ICMM, IFC, GRI, and Voluntary Principles on Human Rights. Worked with various departments and operations to establish SOP for risk registers at all 16 operations in USA, Indonesia, Peru, Chile and Africa. Supported environmental permitting efforts for ESIA and expansion projects. Led the negotiation and development of a major water project development in Peru (120 million dollars).

Projects included: Grasberg, Indonesia, Tenke Fungarume, Democratic Republic of Congo, Cerro Verde, Peru, Candalaria and El Abra, Chile, Morenci, Sierrita, Bagdad, Miami, Bisbee, Ajo Chino, Henderson, Climax, USA. Also served on due diligence team evaluating potential joint venture opportunities.

Prefeasibility Team Environmental Leader: Rio Tinto Resolution Project, Superior, Arizona. 2005 to 2007
Worked cooperatively with world class team of interdisciplinary experts to develop one of the largest, deepest and most complex underground mining operations in world. Developed detail environmental permitting plan for NEPA Environmental Impact Assessment and all related permits for mine and support facilities. Helped to establish stakeholder engagement plan and led many critical relationships building trust. Obtained all permits required for cleanup from past operations and permits for an ARD water treatment plant. Innovative design bypassed expensive reverse osmosis treatment for sulfate removal by sending water to nearby farmers for use on their crops.

Owner/Principal: Nueva Vista Network, LLC. 2000 to 2004
Served natural resource companies by preparing environmental and social impact assessments, assisting with permitting needs, audits, and reviews. Worked on international and domestic economic, environmental and social programs and projects.

Clients include: BP (Indonesia ESIA Tangguh gas development where approval achieved on time), BHP (Arizona water assurance review identifying a number of synergies and cost savings by working cooperatively with other stakeholders and water users in the region), Montgomery Watson (Panama Canal 9 billion dollar expansion. Dubai ESIA lead for 18 billion dollar tri-city development around a world renown wildlife sanctuary delivering approval on time and within budget. Also helped government to establish clear guidelines for safety and health that all projects in Dubai now follow), Inco (Goro Project ESIA advisor in New Caledonia), Rio Tinto (Advisor on Resolution project), and Gabriel Resources (Romania Rosa Montana ESIA leader for major mine ARD and clean-up program, extensive archaeology restoration effort, large resettlement action plan (RAP) and developing impact assessment and management and monitoring plan for what will become the largest gold mine in Europe).

Vice President Environmental Affairs, Freeport Indonesia, Grasberg Mine. 1999-2000
Responsible for helping one of world's largest copper and gold mining operations through very difficult transition period in history of Indonesia and economic recession by managing environmental department, policies, audits and ISO 14001 certification. Key spokesperson for environmental/ social programs. Also oversaw several significant "municipal" projects including permitting and construction for buildings, roads, hotel, schools, golf course, airport facilities, parks & recreation, water and wastewater treatment facilities.

Project Manager and Coordinator, Pinal Creek Group, Claypool, Arizona Cyprus Amax, Broken Hill Property, Inspiration Superfund Cleanup.
Responsible for managing all aspects including planning, permitting and construction for this massive environmental cleanup effort of 3 industry-leading companies with very different corporate cultures and demands for project success. Went through an alignment process with companies to clarify success goals, resources required and greatly simplified communication and reporting needs. Led extensive negotiations with state regulators and communities regarding historical impacts of more than 100 years. Met budget guidelines, consent order and decree schedules. Maintained excellent community relations receiving award from State of Arizona while constructing water treatment plant, piping and pumping facilities, road, and well-fields all under budget and on schedule.

Freeport Indonesia, 1991-1998

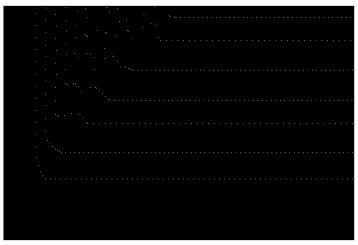
- Vice President Environmental Affairs Grasberg Mine. 1996-1998
  Managed all aspects of one of the largest environmental departments for any operation in the world including extensive monitoring program with large environmental laboratory, large reclamation program and stakeholder engagement program and critical efforts for ongoing permitting to keep construction and mine development on track. Team leader for one of the most complex and controversial Environmental and Social Impact Studies (AMDAL) with over 200 experts including both technical environmental as well as social elements for all aspects of mine. Worked with Rio Tinto experts who were our joint venture partners. Also successfully led coal power plant Impact Assessment process and team delivering approval under very short time schedule.

- Senior Environmental and Public Relations Manager, Jakarta Indonesia. 1994-1996
  Served as company-wide spokesperson and permitting lead for proposed $1 billion expansion. Successfully obtained all provisions, despite some opposition, to expand operations to 300,000 tons per day, more than 7-fold production increase. Worked extensively on conflict resolution issues between development planners and operators and communities and government.

- Environmental Manager, Irian Jaya (West Papua), Indonesia. 1991-1994
  Established a new environmental department and constructed a 3 million dollar environmental laboratory, large reclamation projects, 12 million dollars worth of sewage treatment plants and a state-of-the-art monitoring program. Remedied numerous environmental and social challenges for $4 billion investment. Negotiated favorable win-win agreements with government, NGO and indigenous people.

Ross Mitchell, Ph.D.

Senior Consultant, Impact Assessment and Planning



Dr. Mitchell is a Senior Consultant with ERM responsible for Calgary's Social Team in the Impact Assessment and Planning group. His 25-year career includes impact assessment, social policy, stakeholder engagement, environmental management, and international and rural development.

He has directed a range of mining and energy projects in Canada, Europe and Latin America, including major Social Impact Assessments, Due Diligence, the development and implementation of social assessment and stakeholder engagement tools, and more strategic work in Sustainable Development. He has worked on social policy design and implementation, social management systems, social reporting, and analysis of International Finance Corporation (IFC) Performance Standards such as health and indigenous peoples.

He has also worked for several years as a forester and planning consultant. Dr. Mitchell is a member of the International Association for Impact Assessment (IAIA) and Adjunct Professor in the Department of Resource Economics and Environmental Sociology at the University of Alberta. Countries he has worked in include Canada, Chile, Colombia, Mexico, Panama, Paraguay, Peru, Poland, Suriname, and the United States. His work in Canada includes mining and energy projects in regions such as northern Alberta, British Columbia, Ontario and the NWT.

Fields of Competence

- Social and Environmental Impact Assessment
- Social Monitoring and Management
- Social/ Community Investment
- Stakeholder and Aboriginal Engagement
- Sustainable Planning and Development
- Social and Environmental Policy
- Rural and Community Development
- Due Diligence
- Research

Education

- Ph.D. in Environmental Sociology, 2005. University of Alberta, Resource Economics and Environmental Sociology Department
- M.Sc. in Rural Planning & Development (International), 1998. University of Guelph, School of Rural Planning & Development
- B.Sc. in Forestry (with Distinction), 1987. University of Alberta, Renewable Resources Department
- Diploma in Forest Technology, 1984. Northern Alberta Institute of Technology

Languages

- English (native)
- Spanish (fluent)
- French (basic)

Key Industry Sectors

- Mining
- Oil & Gas (conventional and unconventional)
- Renewable Energy (hydro, wind)
- Agriculture and Forestry
- Government and Non-profit

Professional Honours & Awards

- Outstanding Paper Award at the Society of Mining, Metallurgy and Exploration Annual Meeting, for paper Comparing EIA and ESHIA for Evaluating Mining Projects, 2012
- Discretionary Recognition Award (ERM) for behaviour that demonstrates collaboration or supports sustainability, 2011
- Service Excellence Award and Technical Paper Awards (ERM), 2011/ 12
- President's Award (Golder) for Minera Panama ESIA, 2008
- Alberta Research Council business unit awards for exceptional management and research on EGS (2004), Paraguay (2005), and Rural Sociology (2006) projects

KEY PROJECTS

Social Impact Assessments: Mining

Confidential Client: Peru, Technical Director (2012-ongoing), for two projects: a Social Impact Assessment (SIA) and an Indigenous Peoples study for a major gold mining project in Peru. Issues include community dependency on mining, indigenous people, water quality and quantity, social conflict and land acquisition.

Panama: Project Manager (2012/13), to develop a full mine closure plan for a copper mine (Minera Panama S.A., Inmet) under construction in Panama.

Confidential Client: USA, Social Lead (2012/13), to the Environmental and Social Impact Assessment (ESIA) for subsistence use and recreation, as well as the social and stakeholder engagement aspects of a copper and gold mining project in Alaska.

Chile: Social Support (2011/12), to the Social and Environmental Impact Assessment (SEIA) and Community Relations teams on the social and stakeholder engagement aspects of a copper mining project (Relincho, Teck) in northern Chile (Atacama Region). Issues include water use, sheep herding, artisanal fishing and mining, jobs, indigenous people and human rights.

NWT, Canada: Social Lead (2008/12), for impact assessment (DAR) of a cobalt/ bismuth mining project (NICO, Fortune Minerals) in the Northwest Territories. Issues include indigenous people (mainly Tlicho people; also Yellowknives Dene and Métis), employment and other economic benefits, traditional livelihoods, transport routes, crime, health and in-migration.

Confidential Client: Social Support, 2012 to ERM social team to comply with good international practice on an impact assessment and management plan for a proposed mining development in the Caribbean.

Suriname: Social Lead, 2011 for impact assessment (ESIA) of two bismuth mining projects (Lelydorp and Para North/ Kankantrie North, Alcoa) in the Para District of Suriname. Issues included nuisance (noise, dust, vibration), employment, community development, indigenous people and health and safety concerns such as traffic.

NWT, Canada: Social Lead, 2010 for impact assessment (EIS) of a diamond mining project (Gahcho Kué, De Beers) in the NWT. Issues included indigenous people, sustainable livelihoods, employment and training.

Panama: Social Lead, 2008/10 for impact assessment (ESIA), social monitoring and stakeholder engagement components of a copper mining project (Petaquilla, Inmet) in central Panama. Issues included jobs, pressures on existing services and infrastructure, resettlement and land acquisition, land and resource access, biodiversity protection, indigenous peoples, in-migration, tailings dam safety and security.

Alberta, Canada: Social Lead, 2008/09 for impact assessment (EIA) and public consultation phases of a coal-powered plant (IGCC Genesee, Capital Power) and expansion of coal mining project in central Alberta, intended to produce energy and various by-products while maximizing carbon storage efficiencies. Issues included employment and other economic benefits, traffic, health and safety, air quality and water.

British Columbia, Canada: Social Co-lead, 2009 for impact assessment (EIA) of a coal mining project (Roman Mountain, Peace River Coal) in northern BC. Issues included sustainable livelihoods, employment and training.

Peru: Social Lead, 2008/09 for impact assessment (ESIA) of a copper mining project (Antapaccay, Xstrata Copper) in southern Peru (Arequipa). Issues included community dependency on mining for income, indigenous people, water withdrawals on irrigation and resettlement.

Social and Environmental Projects: Oil and Gas

Poland: Social Lead, 2011 for an IFC-standard impact assessment (ESHIA) and a Community Needs Assessment for social investment of an exploratory shale gas project (Lublin, Chevron) in eastern Poland. Issues included employment, traffic, groundwater use/ quality.

Alberta, Canada: Social Lead, 2010/11 for impact assessment (EIA) of a SAGD oil sands project (Pelican Lake, Cenovus) in northern Alberta (near Conklin). Issues included indigenous people, employment, traffic, recreation and resource use (trapping, hunting).

Alberta, Canada: Social Lead, 2010 for impact assessment (ESA) of a natural gas pipeline project (Leismer to Kettle River, TCPL) in northern Alberta (near Conklin). Issues included employment, indigenous people, traffic and resource use (trapping, hunting).

Alberta, Canada: Social Lead, 2009 on multi-disciplinary team to develop an alternative, conceptual reclamation plan for an oil sands operation in northern Alberta (Suncor). A decision matrix was developed to incorporate stakeholder desires. A dashboard was developed for adjusting weightings of variables to derive alternative reclamation scenarios.

Camisea, Cuzco, Peru, 1997. Designed and implemented a reforestation and soil erosion control project for Shell Peru's Camisea Gas Project. Delivered chainsaw safety courses to 30 construction workers and supervised soil erosion and reforestation activities with indigenous workers (Machiguenga) on 4 exploratory well sites and the Nuevo Mundo airstrip.

Social Impact Assessments: Infrastructure

Suriname: Social Lead (2011-ongoing) for impact assessment (ESHIA) to World Bank IFC Standards of a major hydroelectric and dam project (Tapajai, Staatsolie) in southern Suriname. Issues will include indigenous people, resettlement and land acquisition, livelihoods and human rights.

Colombia: Social Lead, 2011 for cumulative effects assessment (CEA) of a coal mine port (La Guajira, MPX) in the Santa Marta region of northern Colombia. Issues included effects on livelihoods (artisanal fishing), indigenous people, air and traffic.

Alberta, Canada: Social Lead, 2010 for impact assessment (EA) of a highway and river crossing project in southern Alberta (High River). Issues included land and resource use and concerns about traffic.

Ontario, Canada: Project Manager, 2007/08 for an Environmental Assessment (EIA) in southern Ontario for a 180 kilometre widened existing transmission corridor from the Bruce nuclear energy plant to Milton (Hydro One). Tasks included managing multi-disciplinary team measuring various ecological and human components (terrestrial, aquatics, and agricultural) and reporting.

Barbados Water Authority, 2007. Provided socio-economic baseline for a reverse osmosis Triple-P concession development for expanded water supply infrastructure.

Due Diligence – Lender and Third Party Reviews

Tumarín Hydroelectric Project – Inter-American Development Bank (IADB), Nicaragua, 2011. Wrote social component of Environmental and Social Strategy (ESS) of proposed hydroelectric dam project and its potential socio-economic effects on affected communities and people. Review was conducted to World Bank IFC Performance Standards. Issues included resettlement and land acquisition, employment and water.

Minera Media Luna, Morelos - Torex Gold, Guerrero, Mexico, 2010. Performed senior review of proposed gold mining project and its potential socio-economic effects (MIA) on affected communities and people. Included a 3-day field study. Review was conducted to World Bank IFC Performance Standards. Issues included resettlement and land acquisition, employment, water and air quality.

TgP Camisea, Cuzco, Peru, 2009. Conducted a third party review for the socio-economic component of a technical feasibility study of a proposed 150 km natural gas and LNG pipeline in Camisea. Included a 7-day field study. Review was conducted to World Bank IFC Standards, including its potential effects on indigenous peoples.

Nalcor Energy, Newfoundland and Labrador, 2009. Review of Socio-Economic Baseline & Impact Assessment for proposed hydroelectric project and its potential socio-economic effects on Innu communities. Review included technical quality checks, methodology, logic and interpretation.

Canada: Regulatory Framework of Environmental Assessments in Resource Sector, Natural Resources Canada, 2009. Review of the legislative and regulatory framework for Environmental Assessments (EAs) in the resource sector for the federal government. Several case studies were reviewed and interviews conducted with former Project Managers.

Ecosystem Services

Peru: Social Support, 2010 for an environmental cost-benefit analysis of a petrochemical plant in Ica (Marcona, CF Industries) to produce ammonia using natural gas. The analysis considered monetary estimates for the value of natural resources and the benefits or costs associated with their use, as well as the changes resulting from this use. The environmental consequence of project effects on selected components was reviewed and assigned a corresponding cost or benefit value.

Peru: Social Support, 2010 for an environmental cost-benefit analysis of a copper mining project (Antapaccay, Xstrata Copper) in southern Peru (Arequipa). The analysis was based on findings of the biophysical and socio-economic impact assessments. Benefits were considered as an increase in environmental or social wellbeing (a positive effect) and costs as reductions in environmental or social wellbeing (a negative effect).

Panama: Lead, 2008/10 for an environmental cost-benefit analysis of a copper mining project (Petaquilla, Inmet) in central Panama. Supervised and reviewed the preparation of a cost-benefit analysis of the project's predicted impacts, which was conducted to comply with Panamanian regulations. Factors examined included environmental conservation (e.g., biodiversity), natural capital, water quality and social benefits (e.g., road building and maintenance).

Performance and Assurance

Alberta, Canada: Forestry Auditor, 2013. Part of a team who conducted an internal sustainable forest management system, product chain of custody and legal compliance audit of Daishowa-Marubeni International (DMI), Peace River, Alberta, Forest Resource Operations.

Ontario and Quebec, Canada: Confidential Client, 2012. Analyzed social risk factors (due diligence) for a potential acquisition of several properties for wind and solar power projects.

Alberta, Canada: Confidential Client, 2011. Analyzed social risk factors (due diligence) for a potential acquisition of a property in the Alberta Oil Sands and a refinery in Montana.

Corporate Social Responsibility

North America: Goldcorp, 2011. Assessed social indicators for 2010 Corporate Social Responsibility Report. Review was conducted to Global Reporting Initiative (GRI) Standards.

Sustainable Development

Capacity Enhancement for Community and Ecologically-Based Management, Canindeyú, Paraguay, 2004/07. Co-managed 3-year project funded by the Canadian International Development Agency (CIDA) to implement a dynamic, gender-balanced land use planning process in the Mbaracayú UNESCO Man and Biosphere Reserve. Activities helped empower stakeholders (including indigenous people) and aid decision makers to protect ecological integrity and build sustainable communities (including socio-economic and cultural dimensions).

Proyecto Servicio Silvo-Agropecuario, Integrated Rural Development Program, Cajamarca, Peru, 1988/90. Assessed and implemented forestry initiatives with National University of Cajamarca on a CIDA-funded project. Taught forestry management to farmers, technicians, students and indigenous people.

Planning and Policy Research

Environmentally Sensitive Area (ESA) Management, 2009/11. Provided community engagement and social policy support for an ESA project in central Alberta (Red Deer County). Tasks included meetings and interviews with landowners and other stakeholders to understand support for ESA policies and programs.

Nalcor Energy, Newfoundland and Labrador, Policy Support for Energy Project, 2010. Suggested appropriate levels of commitment for policy development for a proposed hydroelectric power generation project. Topics included environment; stakeholder and aboriginal consultation; health and safety; employment and contracting; trapping, harvesting, and property displacement compensation; security and site access; worker relations; and adaptive management.

Manitoba Water Council, 2009. Social Lead on provincial-wide wetland policy project. Designed questionnaire to help identify perspectives on wetlands and obtain opinions regarding a wetland policy.

Social Research

Social Analysis of Air Quality in Confined Feeding Operations, 2008/10. Lead author for study on social challenges and benefits for communities and the livestock industry in Alberta, and how certain management mechanisms could reduce or minimize any negative social impacts. Study was published in April, 2012 by Alberta Agriculture and Rural Development.

Rural Sociological Barriers to Adopting BMPs in Alberta, 2006/07. Designed and managed study on factors linking the environment, food systems and social behaviours related to Best Management Practices (BMPs). Data was collected with farm household surveys, focus groups and interviews. Project results helped client to develop new policy and programs to improve agricultural sustainability.

Social Indicators for Cumulative Land Use Effects Modelling, 2005/06. Designed and managed study on social indicators for input into strategic land use or cumulative landscape effects models (computer simulations to assess potential future trends or scenarios based on plausible policy, management and strategic options for a given region and set of conditions).

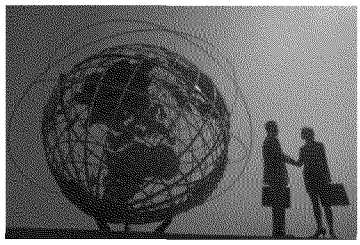
Environmental Goods and Services (EGS) Opportunities for Agriculture in Alberta, 2005. Led social component of study of EGS for the agricultural sector. Conducted surveys, focus groups sessions and interviews with producers and consumers across Alberta. A mail-out survey was sent to 341 producers to gauge understanding and perceptions on EGS and BMPs. Focus group sessions were held in five Alberta towns, and 24 phone interviews were conducted with selected stakeholder organizations.

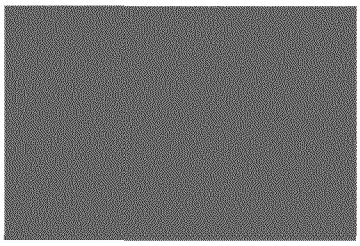
Social Indicators of Community Sustainability for Burns Lake and District, British Columbia, 2001. Led a study on social indicators of community sustainability among Canadian indigenous and non-indigenous residents of a forestry town (Burns Lake, BC), at the Northern Forestry Research Centre, Canadian Forest Service, in Edmonton, Alberta.

Strategy for a Community-Based Vision of Guelph's Future, 1996/97. Evaluated potential for "visioning" (strategic community engagement) for Guelph's future growth and development. Delivered presentation and report to the Guelph Round Table on the Environment and Economy (GRTEE) and the Ontario Public Interest Research Group (OPIRG).

Peter Southern

Project Director





Peter Southern has over 30 years experience in the mining industry. Peter has held senior operational and management positions in mining and consulting companies. Peter is an environmental scientist with expertise in environmental, health and safety policy and strategic development, EHS management systems, acquisitions and divestments, auditing, social and environmental reporting, and sustainable development initiatives.

He has extensive experience in reviewing new projects, both greenfield and brownfield, for both developers and financiers. He has been a team member in numerous strategic planning processes for mines and smelters that established the broad criteria for the operation of those operations.

In addition to technical and strategic advice, Peter continues to provide facilitation skills for diverse meetings including planning for engagement with indigenous communities, providing training in HSE Review programmes, planning for mine subsidence at underground coal mines and general risk management sessions.

Professional Affiliations and Registrations

- Member Australasian Institute of Mining and Metallurgy

Key Consulting Projects

Rio Tinto Iron Ore: Peter led the mine component for the SEIA for the Simandou iron ore project. This was a greenfields project with significant ground and surface water assessment, air quality assessment and the full suite of noise, visual and heritage evaluations applicable to this scale of development.

Confidential Client: Peter led the team addressing health, safety, environment and closure aspects for an order of magnitude study for a potential major new uranium mine. The proposed project considered multiple mining methods, varied processing routes, alternate processing locations to develop a range of potential project scenarios.

Mining and Metals Group (MMG): Peter provided general management support to the corporate HSEC function as well as specific expert advice on public health issues, permit and licence negotiations, development of new projects and mentoring of staff.

Confidential Client: Peter contributed to a due diligence exercise on a potential rare earths investment with mining, processing and transport aspects.

ERA. Peter managed the environmental approvals process for the proposed expansion of the Ranger operation through implementation of a heap leach facility. This project ran through to the completion of the prefeasibility study and included additional strategic advice to the project on a range of other technical projects.

Confidential Client: Provided the environmental component of an Independent Experts report prepared for one of the major mining companies in defence of a potential takeover.

Rio Tinto: Peter conducted an audit of the company's processes for identifying and reporting on potential water supply risks to the business.

Confidential - Major mining company. Peter provided environment, health, safety and community input to the internal project evaluation team on an ad hoc basis. Recent exercises have included uranium in southern Africa and aluminium/ power in central Africa.

Perilya Pty Limited: Provided the environmental input to the proposed merger of Perilya and CBH Resources.

Chevron: Critiqued the company's proposed management plans for the onshore component of the Gorgon project ahead of submission of the report to the WA Department of Environment and Conservation.

Banking Sector Client. Developed a policy to assist potential investment by the bank in mining and minerals processing companies.

Rio Tinto Climate Change. Reviewed an ExCo programme for energy efficiency projects at select businesses within Rio Tinto. This evolved into a project to develop an energy efficiency strategy for Rio Tinto.

IFC/EBRD Review of Siberian Urals Aluminium (SUAL) Upstream Assets. The upstream assets of SUAL were reviewed through site visits, interviews and document review to assess the environmental, social and occupational health issues and liabilities ahead of the potential investment by IFC & EBRD. This referenced the IFC, EBRD and EU standards for operations as well as general industry standards. Sites included were mines, refineries and smelters as well as the associated infrastructure owned and operated by SUAL.

Confidential Client – Banking Sector. Peter led the team reviewing the environmental and social aspects of a proposed investment in a major coal port related project in Australia. This included a review against statutory requirements, best practice expectations and IFC and Equator Principles for similar developments.

Perilya Pty Limited. Peter provided a strategic review of the company's performance against the ICMM sustainable development principles and ongoing advice on EMS, general environmental management and corporate assurance processes.

Perilya Pty Limited. Peter led the team providing strategic advice on assurance processes and public reporting of HSE performance.

Perilya Pty Limited. Led the review of the existing HSE management systems at the Broken Hill operations and made recommendations for improvements.

Confidential Client. Led the review of the client's lead management systems and health risk assessments for a lead/ zinc mine in an historic mining centre.

RJ Workspace. Peter assisted this furniture manufacturer to map their current status against various green manufacturing codes and developed a strategy to ensure RJ Workspace met international standards for furniture manufacture and supply.

Aquiline Resources, Social and Environmental Impact Assessment for Calcatreu gold project, Argentina. Peter led the technical review of the existing environmental and social information and comparison with international and national requirements to prepare an international standard SEIA for the project. The management plans and likely mitigation measures were developed to meet best practice standards.

ICMM-IUCN Good Practice Guidance for Mining and Biodiversity. Project director for the preparation of the first draft guidance documents released by the International Council on Mining and Metals. This project brings together the global experience of mining houses, academics, government and non government bodies to improve the performance of the minerals industry in identifying and managing biodiversity issues.

WWF Minesite Certification Evaluation Project. Peter led the initial audits to test the applicability and practicality of WWF's proposal to certify individual mine sites against a suite of economic, environmental and social principals. Sites audited included a major underground lead zinc mine and a large underground gold mine.

CBH Resources water and tailings management plans. The tailings and water management options for CBH's Endeavor mine were reviewed and options developed. This mine is a zero discharge site so water quality aspects were critical. Tailings capacity needed to be increased and options to increase storage densities and tailings slopes were identified.

CBH Resources Endeavor Mine. Prepared a closure cost estimate for the mine using the NSW Government's closure estimation toll and justified variation from the standard rates.

CBH Resources RASP mine. Peter led the team preparing the Part 3a Planning approvals (equivalent of an EIS) for this major redevelopment of the old central mine in Broken Hill, NSW.

Ashton Mining (Coal NSW). Peter conducted the risk assessment for the proposed underground coal mine,

leading to the development of a subsidence management plan subsequently approved by the regulator.

BANPU (Thai coal company). Peter provided advice to Banpu on HSE management systems including conduct of an initial review of issues being addressed at their Thai and Indonesian coal operations. ERM Thailand continues to support Banpu.

BHP Billiton. Participated in the annual verification process for BHP Billiton's social and environment report.

Pilbara Iron. Led a desktop review of dust control practices at a number of major ports in Australia.

North Limited. Peter contributed to this M&A process. This major mining house was acquired by Rio Tinto and all health, safety, environmental and social aspects and liabilities for the many operations owned by North were examined. This included base metal, uranium, iron ore and manufacturing sites across the globe.

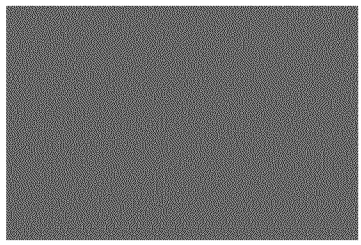
Confidential Target. This major mining house was a potential target and its global operations were reviewed and potential liabilities, costs and potential solutions identified and costed to determine whether a bid would be made. The sites included alumina, base metal and industrial minerals operations. Of specific interest was a major uranium/ base metal operation.

Auditing and Reviews. In addition to the audits and reviews mentioned above the following sites have been audited or subject to strategic reviews by teams of which Peter has been either leader or team member.

- Diamond Mine, Canada
- Titanium smelter, Canada
- Iron ore mine and pellet plant, Canada
- Titanium mine and smelter, South Africa
- Gold mines, Zimbabwe
- Nickel refinery, Zimbabwe
- Gold mine, Indonesia
- Gold mine, PNG
- Zinc refinery, Argentina
- Zinc mine, Argentina
- Tin/ Lead mines, Bolivia
- Gold mine, Brazil
- Nickel mine and smelter, brazil
- Iron ore mine, Brazil
- Copper mine, Chile
- Steel Foundry, Chile
- Borates mine and refinery, USA
- Copper mine, USA
- Talc mines and plants, USA
- Gold mine, USA
- Coal mines, USA
- Steel foundries, USA
- Diamond mine, Australia
- Iron ore mines, Australia
- Coal mines, Australia
- Copper smelter, Australia
- Gold mines, Australia
- Power station, Australia
- Mineral sands mine, Australia
- Uranium mine, Australia
- Silicon Smelter, Australia
- Zinc refinery, Netherlands
- Talc mine, France
- Borates processing plants, France, Spain
- Steel powder plant, Germany
- Uranium mine, Namibia
- Hydro power scheme and aluminium smelter, Cameroun.

Daniel A. Yamashiro, P.G

Technical Director



Supervised, managed, and participated in assessments and remediation projects in both the United States and Europe for 30 years. Directly involved with on-site restoration of ground water, surface water and soil utilizing integrated environmental equipment systems and applying innovative and cutting edge technology. Past manager on projects involving large-scale product recovery systems, above-ground and in-situ bioremediation, and natural attenuation. Conducted geophysical evaluations as part of stratigraphic analyses to assess ground water and product migration pathways in the subsurface. Conducted hydrogeologic studies for semiconductor, petroleum, mining companies, and local and state governments. Managed projects concerning human health risk assessments.

Project management experience ranges from sampling underground storage tank (UST) pits to designing and supervising the installation of complex integrated remediation systems applying chemical oxidation, bioremediation, as well as environmental forensics to distinguish source areas. Project consultant on long-term ground water monitoring programs under RCRA, VCP, Compliance and Enforcement authority. Conducted project management training programs emphasizing budget control, on-time delivery, and maintaining the agreed scope of work.

Developed assessment programs and remedial strategies for mining facilities, petroleum terminals and refineries. Managed one of the largest UST petroleum-related clean-up projects in Arizona. Developed and implemented the remedial strategy for one of the largest product releases (greater than 600,000 bbls) in Texas. Experience involved PCE, TCE, DCA, acetone, methylene chloride, petroleum, and other VOC releases to the environment

Registration

- Registered Professional Geologist in the State of Texas
- Registered Professional Geologist in the State of Tennessee

Fields of Competence

- Project management
- Stratigraphic analysis and facies analysis
- Downhole wireline log analysis
- Environmental site assessments
- Soil and ground water remediation
- In-situ and above-ground bioremediation
- Monitored natural attenuation
- Product/ DNAPL evaluation and recovery
- Pipeline leak assessment and HCA analysis

Education

- M.S. Geology, California State University
- B.S. Geology, California State University

Countries Worked

- United States
- United Kingdom
- Belgium
- Bermuda
- Barbados
- Brazil
- Italy
- Germany
- Mexico
- Netherlands
- Portugal
- Sweden

Recent Key Projects

- Evaluated the cause of recovery well efficiency reduction and decreased performance of a ground water and product recovery system and identified the multiple factors attributing poor performance. Subsequent to the evaluation, a pH monitoring and feed system was designed and construction and system specification documentation provided to the client for their internal engineering group to install.
- Conducted feasibility and cost-benefit risk management analysis to provide infrastructure or operations alternatives for companies to assess as part of their overall business strategy. Projects involved an assessment of the cost benefit of utilizing larger load helicopters verses an existing fleet of smaller helicopters for emergency response actions; an assessment of the number and location of permanent oil spill containment site locations to reduce response time and expense in the event of a major oil spill; an assessment of frequency/ consequence of release causes along a pipeline to identify mitigation measures, develop a prioritization plan, and cost/ liability reduction.
- Developed a risk management strategy to identify potential worst-case leak locations along the 800 mile trans-Alaskan pipeline and evaluate where emergency teams could intercept an oil spill based upon transit times between response bases and containment sites. Developed algorithms for a screening fate and transport model integrating estimated spill response times and assisting in preparing computer code for the final screening model. The resulting information was then used to assist Alyeska in assessing pipeline operation and staffing reconfiguration options.
- Assisted with the development of a baseline-risk assessment to identify spill response, remediation, and monitoring costs from 1200 potential leak locations along the 800 mile trans-Alaskan pipeline. The evaluation built upon earlier work and required development of a response time model and upgrading a screening fate and transport model to address oil spreading, infiltration, downriver flow, and different hole sizes in the pipeline. Integration of spill response time model with the spill fate and transport model identified the potential magnitude of a release and potential consequences upon which cost could established. 1213 pipeline segments where used in the assessment with risk, consequence, and remediation cost developed for each segment. Results of the assessment identified variation of risk along the pipeline.
- Assisted client in developing and implementing hybrid procedures to analyze High Consequence Areas (HCA) under DOT regulations for the trans-Alaskan pipeline. The final procedures integrated fate and transport modeling with geographical information systems (GIS) and custom computer code to identify the risk of affecting an HCA in the event of a release from the trans-Alaskan pipeline.
- Specified and designed numerous Class V injection wells for chemical oxidation remediation projects. Well design addresses material compatibility, pressures, flow, formation permeability and effective radius of influence.
- Evaluated remedial options for a crude oil release from an above ground storage tank at a pipeline pumping station. The evaluation was based upon a product migration assessment through fractured mudstone, natural attenuation parameters indicating aerobic biodegradation, and applicable technologies available to remove crude from the subsurface. The crude oil reached ground water and volatile constituents dissolved into ground water ahead of the plume. The remedial options evaluation included skimming via recovery wells, steam injection, hot air injection, recovery trenches to address the crude oil, and an oxygen release com-pound (ORC) curtain to address the down gradient dissolved components.
- Conducted a value engineering assessment to identify response actions options, prepared work plans for implementing a recovery system evaluation, and conducted the response action testing at a resins facility in East Mexico. The testing was conducted to evaluate the efficacy of a preferred response action. The testing was unusually demanding due to the presence of the site infrastructure (piping, equipment, traffic) and subsurface volcanic stratigraphy. Testing, which was based upon another consultant's work, identified that some response action tasks were not viable and required additional enhancements to address site variability.
- Conducted a product forensics study related to the release of a historic crude oil release. Site remediation was ongoing but due to an increase in product thickness at the site, a subsequent release was suspected from either a nearby tank farm or from crude oil and product pipelines within an adjacent pipeline corridor. The forensics study involved a soil vapor survey and product-fingerprinting program. The soil vapor survey identified anomalies suggesting potential sources of a subsequent release. The fingerprinting program included sampling product from several wells across the

site and identifying biomarkers and other key forensic ratios to identify different product types.

- The impact of two crude oil pipeline releases was evaluated as to environmental impact to a nearby creek. The evaluation consisted of review of the analytical results from ground water sampling events, assessment of hydrocarbon plume stability, and demonstrated natural attenuation conditions. In addition, a risk assessment was conducted utilizing the Domenico and Schwartz transport equation which quantified a worst case benzene concentration assuming that no mixing between creek water and shallow ground water occurred.
- Managed a multimillion dollar design, installation, and operation of a large-scale remediation system for a major oil company. Designed the screen specification for three 900-foot long horizontal wells and developed construction specifications for a 3600 scfm thermal oxidizer with PLC technology. The remedial program was to recover product from a refinery that migrated with ground water under an adjacent town using horizontal SVE technology. Coordinated construction efforts and startup activities and prepared and implemented training to operate the system.
- Completed site investigation for cargo pipeline and identified impact to soil and ground water within an ecological sensitive area. Ground water at site is semi confined. Remedial options were evaluated and project costs identified for each alternative using root mean squared estimation method. The selected remedial approach was to employ chemical oxidation into the affected soil and groundwater and reduce the mass loading so that a natural attenuation program could used. The strategy was designed to reduce short-term capital costs and enable management of long-term client cash flow. In addition, because of the sensitive area, an infrastructure to support traditional remedial alternatives was not available. Renegesis' Regenox® was selected as the oxidant for the site.
- Designed and implemented a long-term SVE pilot test to obtain data to design a full scale SVE system for refinery. Final design was based upon critical pore-gas velocity, hydrocarbon recovery rate, and heat value of VOCs. Final system design utilized two custom designs and fabricated thermal oxidizers (9 million BTU/ 900 scfm each), an initial 15 SVE wells to 100feet bgs, and nearly one mile of welded steel piping. Design process included refinery MOC and significant HAZOP input from several operational managers.
- As part of a site closure evaluation under Railroad Commission of Texas jurisdiction, the effects of oil field brine injection on chloride levels in ground water and the resulting reduction in natural degradation of petroleum-related hydrocarbons were identified. A case was made that established that oil field operations in the 1970s impacted ground water and hydrocarbons can still be in ground water from these operations and not from a recent loss from a pipeline in the area. Railroad Commission closure decision is pending.
- Conducted a NAPL mobility assessment to ascertain the subsurface migration pathway of NAPL though consolidated rock beneath a pipeline gathering station. Ground water monitor wells indicated that NAPL was present at the water table but the movement through the formation was non-uniform suggesting lithologic variability and structural control influencing movement. The assessment consisted of pumping tests and correlation of lithologic units identified by coring and drilling to develop a site conceptual model. Once the correlation was completed, the NAPL mobility was modeled using API software and guidance documents. As part of the mobility assessment potential oil transmissivity was defined, direction and location of NAPL movement and occurrence identified, and thickness (oil saturation) at which the NAPL would reach equilibrium and no longer migrate calculated.
- Designed and installed an 830-foot horizontal vapor extraction well with a 1600 scfm SVE system and thermal/ catalytic oxidizer. The well screen was designed to create uniform air flow along the well's length and installed within coarse gravelly glacial moraine geology. The well and system was designed to volatilize hydrocarbon vapors from a product plume which migrated under a residential community from a now disused refinery.
- Assessed the presence of dissolved hydrocarbons and product to develop a strategic remediation plan for an inactive refinery in northeast Italy. The refinery was waiting decommissioning and redevelopment as a housing and shopping area. The assessment identified widespread (30 acres) dissolved hydrocarbons and several large localized occurrences of product. The product plumes included crude, diesel and gasoline. Depth to water was one meter. The strategic remedial plan was developed based on the owner's long-term management plan and future land use designations. Estimated remediation costs not including decommissioning were 20 billion lira (U.S. $19.5 million approximately).
- Responsible for assessment, design, installation, and operation of a large-scale biosparging project at a petroleum terminal in Sicily, Italy. The project involved

an 11-acres area impacted by adsorbed hydrocarbons and NAPL. The system was designed around existing facilities and used 45 monitor wells, 52 bioventing wells and 63 biosparging wells. Stratigraphic heterogeneities were also a determining factor in the overall layout. The design and layout of the sparge component intended to assist in product recovery as well as volatilization and bioremediation of diesel. Cleanup objectives were met within two years.

- At Sky Harbor International Airport, managed the design, installation, and operation and maintenance of a soil vapor extraction system to recover product in cobble conglomerate geology. The product was jet fuel lost from the fueling system for commercial aircraft. The system required three thermal oxidizers to oxidize the mass recovered and flow from the soil.
- Managed the design, installation, and operation and maintenance of a nine-well vapor extraction system with thermal oxidizer and heat exchanger. The system was designed to recovery product from a depth of 120 feet from silty fine sand. The product was lost due to e-line leak at a fueling depot for City-owned vehicles.
- Developed a remedial plan and executive design for the clean up of TCA, PCE and BTEX for a pharmaceutical company in London, England. The plan required installation of a reactive barrier utilizing in-situ packed columns of zero-valence iron and activated carbon.
- Developed a remedial strategy for the cleanup of ground water impacted by TCE and PCE and the implementation of that plan for an appliance manufacturer in Varese, Italy. The plan required the containment of plume migration using a ground water pumping system.
- Evaluated remedial options for the cleanup and site development of a gas works facility in London, England. The remedial plan involved installation of a bentonite containment wall around the property, removal of "hot-spots" in the vicinity of the proposed building location, working with building engineers to develop passive venting of potential build-up of subsurface gasses, and a new surface water collection system to reduce infiltration within the containment area. Chemicals of concern were PAHs, phenols, sulfates, and liqueurs.
- Designed and implemented a pilot remediation program to biologically degrade gasoline and PAHs in soil in Gothenburg, Sweden. The pilot program involved conducting a bioassay to first determine the presence and population of hydrocarbon -degrading bacteria and the design of an operating test plant to determine parameters to optimize bacteria growth and hydrocarbon degradation.
- Assessed, designed, installed and operated a dual-phase vacuum extraction system at a telecommunications facility in Harlow, England. Identified a DNAPL TCE and PCE plume confined within a sand lens bounded by clay covering an area about 360 square yards. The design involved developing a hydrological containment system to recover dissolved hydrocarbons, reduce further diffusion of DNAPL, and dewater the sand lens. Once dewatering occurred, ganglia and DNAPL recovery was enhanced by soil vapor extraction which increased the rate of remediation.
- Investigated and designed an enhanced soil vapor extraction system utilizing a ground water pump and treat system integrated with soil vapor extraction (VES) at an abandoned laundry facility in Gelsenkirchen, Germany. The system was designed to provide hydrogeologic containment and recover dissolved phase TCE PCE impacting an area about five acres
- Designed and installed a trench and sump system to act as a barrier of product migration to an adjacent harbor for a refinery in Sicily Italy. The project needed to overcome tidal fluctuation, pump system corrosion from brackish water, and a varied geology and hydrocarbon mix. All work and system installation had to be around existing facilities.
- Responsible for assessment, design, installation and operation of pump and treat, vapor extraction systems, above ground biopiles, air sparging systems at gasoline stations world-wide.
- Developed Spill Prevention, Control, and Countermeasures (SPCC) plan and Contingency Closure Plans (CCP) for seven facilities of a major aircraft manufacturer. The scope of work involved auditing all facilities to ensure hazardous material containment systems met regulations, specify corrections, and document the containment systems engineering and compliance. Also, emergency cleanup and evacuation plans were developed in the event of a hazardous materials spill.
- Managed a ground water modeling and feasibility study for the remediation of cyanide and mercury related to heap-leaching gold mining operations. The project involved modeling ground water flow conditions and contaminant transport; analysis of fracture flow through granitic bedrock; and a thesis on the relationship of mercury formation in the presence of cyanide. Remediation alternatives focused on utilizing existing mine facilities as part of the

remediation program to stop off-site migration of cyanide and mercury and the treatment of recovered ground water using natural ultraviolet light.